# IN THE ABSTRACT

*BY THE SAME AUTHOR*

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BY

NORMAN ALLISTON

TRANSLATOR OF "THE REFLECTIONS OF LICHTENBERG"

LONDON

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# IN THE ABSTRACT

## The First Law of Motion

To Newton it first occurred that the simple act of falling required some power, some cause. It is said to have struck him in a genial moment that an apple had to be *made* to fall. I need hardly say that it was a pregnant thought to have; and how original it was is shown by the fact that innumerable eyes had been continually witnessing the phenomenon for ages previously without ever having had any other idea than that it happened of itself. For a thing to move upwards, yes, that required force; but downwards—why, as we knew, a thing did it of its own accord without any help.

So Newton, then, grasped this elementary motion that we see on all sides under an entirely new form, and viewed the falling body as carried by some force towards the ground, whereby the whole phenomenon acquired a fresh and indeed magical character. Yet it must be accounted curious, I think, that our great philosopher did not apply his significant idea to all allied cases, but restricted himself essentially to that of the merely falling body. By what mischance was it that he never asked himself how a body rolling

along the level travels forward, and whether here too, just as in falling, some cause was not required to produce the effect? The Newtonian eye, one would have thought, would have seen in this movement, which ordinarily is viewed without any mystery and as occurring automatically and of course, the same occult application as it did in the case of a simple fall. For really, it is just as much a question by what means an apple rolls along the ground as by what means it falls to the ground. We can, of course, say with the common man that, someone having started the object rolling, it naturally keeps on of itself. But those who are satisfied with this explanation can have no objection against applying it in the other instance, and saying simply that a body falls of itself. If, however, gravitation must be called in to account for this second case of motion, I see no reason why we should be able to dispense with it in the first.—Look at this cricket ball speeding along the turf. I know, indeed, that an instant ago, a man applied force to it with his bat; but who or what is making it travel now at this subsequent instant? Not the hitter, certainly. No doubt, it seems to us when we strike or throw a ball, that the motion it is set in is altogether due to ourselves. This, however, is because our experience is confined to what happens on the surface of the earth; but could we adjourn our games upon occasion to some alternative planet, it would soon be apparent that another power than ours was controlling the flight and run of the balls. We might use exactly the same exertion as before, and apply it in exactly the

same way, yet it would be an impossibility to make a ball travel on the moon or on Mars as it does here. The truth is, that in giving a thing motion, we merely initiate an act that nature carries out independently in its own way. The moment a missile leaves our hands, some other power takes charge of it and keeps it on its course at a rate that we have no voice in whatever.

Now, this way and carry that a body acquires in being sent along, Newton was content, as science after him to this day is content, to explain as automatic; and while he conceived that a falling body did need some continuous force to pull it, he taught in effect that one rolling along the level needed none: it was sufficient merely to start it, and, nothing interfering, it would go on of its own accord, or automatically, for ever. This is expressed in the so-called First Law of Motion as follows: "Every body continues in its state of rest or of uniform motion in a straight line, except in so far as it may be compelled by impressed forces to change that state." This law is said to emphasize "simply the inertia of matter—*i.e.* a body cannot alter its state of rest or motion, any such alteration requiring external force." Elementarily, however, motion is not a staying or state at all, but clearly a continuous alteration. And any alteration, it is explained, requires external force; in other words, a cause. In this, it seems to me, rest and uniform motion in a straight line are not on the perfect par that the above law would put them. Rest is perfectly uniform, whichever way we look at it; but not so motion,

which, although in so far as pace and direction go, it may be but one and the same, as regards place involves continuous change, and so in logic continuous cause. I must admit that in a world like the present, where change is so much the order of the day, and where it is only with the utmost difficulty that things are kept as they are, that it is possible and even consistent to conceive of motion as the positive subsisting of itself, and of rest as the negation forcibly requiring to be caused; but then, in this case, it is difficult to see why gravitation should be introduced at all.

Physicists in this matter seem to have had their eye exclusively upon the prevention of motion; for seeing that it does require a cause to bring it to a stop, they conclude that in the absence of friction, collision, or other hindrance, a body would go on for ever, the maintenance of motion in their view not needing any force. Motion as a positive alteration they have left altogether out of view; and so, except for the starting, we hear never a suspicion that it has to be occasioned. But in motion, a body does not only move out of its original place, but out of all subsequent places; and with regard to these it might be asked how in the absence of any force to remove it, it is ever removed; this reason, that "there is an absence of force to remove it," being held perfectly valid in accounting for the fact of a body not moving out of its plane; and what applies to the plane, this "point" of the third dimension, must surely apply to the point itself. The following argument may also be used to show the inadequacy of the merely

preventative view of motion—the view, I mean, that once started it continues of itself unless actively stopped. If the freedom of a body to continue moving is sufficient reason that it should continue, why should not the freedom of a body to start moving also be sufficient reason for it to start? This, however, is not the case: we can imagine a body quite free to move in any direction, but we do not think that sufficient for it to do so without some positive cause. Equally, then, with regard to the moving body; it may be free to keep on moving, but if it is to do so, it must be caused to. The merely negative conditions of nothing in the way, no friction, no air resistance, and the like, are not enough to insure the positive event of perpetual motion.

The idea that motion can go on of itself, and, once initiated, no more requires force than rest, is evidently derived from common experience. Having given a push to a thing we find that it keeps on for some distance by itself; on ice it travels a long way, but not far on a rough surface. Again, a top once well set going makes as if it would spin forever, and obviously no hidden force interferes to bring it to rest. Seeing this, it is borne upon the observer that, were it not for friction or other resistance, these motions might continue interminably. And in the conviction that they would do so there is expressed simply the inconceivability that matter can do anything—either start or stop—by itself, of its own effort or exertion. But, on the other hand, if matter really is inert, how can it continue to produce that constant alteration involved in motion?

for the force of projection directly acts only at the commencement of a body's flight, and to give this as the cause of the continuance of motion is to say that a finite act can produce an infinite effect. That I support a body for a moment is not sufficient to keep it supported forever; nor is any momentary thrust, however much one subtracts from friction and resistance, sufficient to keep a body travelling forever. This is indeed so patent that no one first hears of the doctrine of inertia in movement without greatly doubting, if not entirely disbelieving, the conclusions drawn from it. Our very just scruples are, however, generally overcome by considerations which I must regard as sophistical.

The deduction that because friction stops a ball rolling or a wheel revolving, the absence of friction or other opposition would allow them to keep on interminably, appears to me to be faulty in this, that it makes no allowance for a conceivable privative effect—I mean for the ceasing of the cause that may, or rather, must have been carrying the bodies on. For it is not only positive collision or resistance that will bring a free body to a stop; the removal or exhaustion of the agency that held it in motion may do so quite as effectively. This is a case, to be sure, which does not occur in practical experience, but it is no less predicable than frictionless motion. Indeed there is one thing which the observer we mentioned above has not taken into account: ground friction, the resistance of the medium, and such like, he has carefully noted; but he has not asked himself where his experiments are being

carried out. He has not considered his position on the surface of the earth as one of the conditions of the motion he is watching. If this had crossed his mind, he would not only have eliminated friction, as the expression is, but he would have eliminated the earth as well and the rest of the universe—all except himself and a ball to throw. In this situation, I figure to myself, an object would go as far as pushed, as far as the blast of an explosion or the thrust of an arm carried it, and then stop dead; for no carrying power could be given it. In a word, I contend that there is no free motion without gravity.

It will be obvious enough that the statement I make no more admits of direct proof than the statement it opposes. Certainly no one can point to any instance in nature of a body which, having once been set in motion, keeps it up uniformly and indefinitely in the same direction; nor can I for my part show any body which, upon the sudden annihilation of all neighbouring bodies, comes to a stop. It is an academical matter for the understanding to decide, a formal point not even affecting the methods we use in calculations concerning motion. This being so, it only remains to approach the issue indirectly by means of various hypothetical instances and by drawing inferences from what is generally admitted or known. And here I will give notice once and for all that any motion considered in this discussion is to be understood as occurring unimpeded by friction, by the resistance of the medium, or the like hindrances.

So as to lead up by steps to my ultimate position, I have first imagined a case in which by a gradual increase of centrifugal force gravity is *virtually* reduced from much to little, from little to less, and from that to nothing. The reduction is virtual and not actual in that, although a loose body at the equator under the increasing action of centrifugal force would become lighter and lighter to a person travelling round upon the earth with it, until at length it floated from off the ground; yet the two bodies—I mean the earth and the body on it—would not have altered their distance, and so in reality there would still be the same play of gravity between them as before, only that it would then be telling in a different direction. This being premised, let us consider the case of a man whirling a weight round at the end of a string, and suppose that as he swings it the earth comes to rotate quicker and quicker. Another condition we institute is that the swing shall be just strong enough to keep the string level and make it trace a horizontal plane. This minimum rate at which the weighted string must be twirled to keep it level will evidently decrease in measure as gravity is virtually decreased; for the weight will be drawn less and less towards the centre of the earth, or "downwards," and so will need less keeping up. Ultimately, when the earth's rotation has become such that gravity is fully counterbalanced, no swinging will be needed at all; for the weight having then become a satellite will keep its position of itself, tending neither upward nor downward. That is one consideration: here are

two more. At first, while the man is swinging his weight at the given minimum, he feels a strong pull on the string; but to maintain this tension during the virtual decrease of gravity, I suppose that the rate of swinging would have to be gradually increased, until at the stage when gravity were completely counteracted, it would have to be increased to infinity; which is to say that however fast the string were then whirled, no tension would be produced, and the body, being perfectly balanced, would as little tend outwards as up or down. But, in the first place, under these conditions the weight could not properly be whirled at all, let alone at an infinite velocity, since it is only because of a stress that it can thus be made to describe a circle, unless indeed the attachment is a rigid one. Without augmenting the velocity, then, it would become increasingly difficult to make the weight follow this path. In the last resort, when gravity were virtually nil, the string could only serve to pull the weight directly, and so the man would have to make the whole circle with his hand, real swinging having become impossible. Before this equivocal situation is reached, way can always be given to the body, because, though it becomes as light as a feather, which would ordinarily affect the impetus, we have eliminated all incidental resistances; so that the least application would suffice to set it moving, and it would no more lose momentum than a greater thing or the same thing under greater gravity. But subsequently the body is in perfect equilibrium, in which position to shift it would be as easy as moving

nothing, yet within that spherical plane and under those conditions it could not be made to keep in motion by itself. This may also be seen from the following fact. The resistance required to stop the weight while it is circling at the minimum velocity necessary to keep its attachment level, would grow less and less with the virtual diminution of gravity; and eventually there would come a point where, both quantities disappearing, no resistance at all would be required to stop the motion—that is to say, it would stop of itself, or more properly would never be begun.

This hypothetical instance is complicated and requires a great many assumptions; for in nature one thing cannot be altered without in a measure altering all others beside. To mention nothing else, the weight is only still to the manipulator, who is himself, by the very terms of the hypothesis, travelling at a great speed round the earth's axis. Yet notwithstanding the allowances that have to be made, I thought it well to introduce the case, even at the risk of prejudicing the argument, inasmuch as it leads gradually and as it were through channels of experience to the truth I seek to establish, that mass alone will not carry on a body, but mass under the influence of some other mass only.

The various conditions and restrictions I have to suppose in an example such as this one all automatically fall away if we so adjust our understanding as to consider a single rigid body alone in space. Here a body is perfectly balanced, not in virtue of its motion and the distance from a centre of

gravity, but simply because nothing enters to disturb it. It is in such a position that force can have an immediate effect on it, but no after effect. If a force acts on it temporarily, it answers temporarily; for immediately it is left, it regains its perfect balance, having no cause to go on, as it has when started within the field of influence of a second body. Hence although it is so easy to be moved, no proper motion can be given it. The least imaginable pressure makes it yield place, and yet however swiftly it is driven, it never acquires any carry of its own: it goes as far and as fast as it is pushed, and then stops. For no resistance being required to bring it to rest, it stops of itself, the very first conditions under which alone a thing can keep in movement being absent. Perhaps it will be objected here that the "no resistance" argument is reversible, and can be used in opposition; for instance, in this way: The attraction upon a body growing less, less and less force will be needed to set it in motion, until at length none will be needed, and it will start of itself! Indeed, it is true that no force would be needed to move our insulated body, as it would offer no resistance whatever; but in being moved, if we can imagine that as being done by some ghostly agent, it would never acquire any velocity of its own. A body in motion, I fully allow, can no more stop of itself, or by its own power, than at rest it can start to move of itself; but the point is that unless acted on by some second body it can never have this motion to begin with; and hence if, when isolated, it could be thrust along, it would stop dead at the end of the

thrust, not because of any active power to stop moving, but because in reality it had never even begun freely moving; it never went along by itself; it was moved, but not set in motion.

Speaking exactly, I do not deny that a body once in motion requires external force to stop or alter that motion, but I deny the assumption contained in such a statement, namely that it is originally and unconditionally possible for a body to be in motion. I see that, if there is no second body, it cannot be got into that motion from which, were it possible for it to be in, it could then not desist. Having regard to mere form, it is of course quite as right and consistent to imagine an original body in motion as at rest; but not if we have regard to cause and connection. If anyone were to set up a law to the effect that a body, once in circular motion, continues in that state except in so far as compelled by external force to change it, he could not well be given the lie direct; but it would be pointed out that certain conditions had to prevail before a body could get into circular motion, and consequently that his law assumed too much, and did not begin at the beginning. I say exactly the same of uniform motion in a straight line; I affirm that it is not unconditionally possible, as rest is. It does certainly stand to reason that if change of momentum is made the measure of force, and if no forces are allowed to act, then a body once in motion must continue in it; but there is the initial difficulty of getting the body to be once in motion, and unless there is a second body to make mass effective, it is in the natural course of

things an insuperable one. For all these reasons, then, I conclude that any perfectly isolated body must be at rest, yet without prejudice to the passivity of matter. I do not, that is to say, pretend that matter affects rest any more than motion, but agree with the received principle that it is indifferent, only adding that on these very grounds it requires positive conditions to enable it to undergo the constant alteration involved in motion.

It would form a very glaring inconsistency in my proposition if, having asserted that a single body alone cannot be in or get into motion, I were then to allow that upon the introduction of a second, all sorts of motion were suddenly made possible. If the case stood thus, then while the single body could not alone be projected in motion, with another body at the side it could be; and in this there would be an obvious contradiction, because we cannot imagine the second body suddenly bringing a new virtue into universal existence. With the introduction of this second body, in effect, a certain mutual action would be set up; the first would lose its perfect equilibrium, and motion would in so far begin to be possible. But it would be strictly confined, and in fact would all be about a single point, which itself by previous reasoning I judge would necessarily be stationary. For these two bodies may be regarded as but one in mass, and so if no other body is acting on them, they must collectively be at rest, whether they are in motion among themselves or not. To put this in a slightly different way, the mass of the two bodies can only tell in so far as it is separated; as a whole it is in

exactly the same position as the mass of a single body, which, we have seen, is in isolation perfectly balanced and not receptive of motion. The two bodies, then, cannot be travelling together, but whatever motion they may be in, it is simply among themselves: the mean velocity also, as well as the place, must be absolutely determined. And what applies to the two bodies together will obviously apply to three together, to four, or to any number: as an isolated whole no impetus can be given them, and so collectively they remain where they are. In fact we may be certain that all the worlds in the universe keep in the same great place, the whole having no proper motion. It is indeed well enough known that "the motion of the centre of mass of a system is not affected by the mutual action of the parts of that system"; but as it has not been recognized that mass requires the influence of mass to enable it to travel, it is thought that an isolated system of bodies might just as well be in motion as at rest; and so it is said of a system's centre of mass as of the single uninterrupted body, that its velocity is constant. To this I object that, except under conditions of attraction, no such motion could ever be initiated, let alone continued.

From these highly abstract considerations about bodies or systems of bodies by themselves we may now return a little more to earth. But before applying the principle thus arrived at to the case of the planetary motions, the flight of projectiles, and the like, I will first touch on a point in regard to

which I might otherwise be accused of assuming too much. It is this. In the ordinary way, as we only have to deal with bodies which are all under one attraction at a given remove from the centre of gravity, we say that the different resistances they oppose to being moved or being stopped are proportioned to their masses, other things being equal. But where we deal with the same body under different gravitational conditions it will be evident that this rule no longer holds; for it does not really depend on the mass of it, how difficult a body is to shift or to stop, but in what degree the mass is being acted on. Yet apparently with the object of showing that a body's inertia depends absolutely on its mass, independent of gravity, I have seen the fact cited that a weight supported by a balloon opposes as much resistance to being moved as when unsupported. To this I have to remark that however the attraction on a thing is counteracted, it is not really lessened thereby. Gravity's pull on a ship is just the same, whether the vessel is in dry dock or supported on the sea; and it is the same on the weight, whether that is held by a balloon or not held. For the counter-pull does not remove the original one; it merely prevents the latter from telling on a body in the direction in which it is counteracted. But were gravity really, and not thus ostensibly lessened, as for instance by the removal of the body a hundred miles or so away from the earth, it would then oppose less resistance to being moved or stopped; for though the mass is the same in both cases, the influence it is under is not. I am particular in emphasizing this distinction, because it seems to be

thought by some that to counteract the direct pull of gravity is equivalent to a positive annulment of gravity; whence, having in mind some experimental fact such as that of the balloon-supported weight, the erroneous inference might be drawn that a body's inertia has no connection with the gravitational stress upon it, but is due to something inherent in it. As I say, whether a body presses with its whole weight upon the ground, or is supported just above it, the same attraction is still exercised upon it; hence the resistance it opposes to being sent horizontally along is substantially the same in either case; but it would not be so, were there to be any proper diminution of gravity. I visualize this case by imagining a strong elastic acting in place of an occult attraction; and I see that were a second strand, acting oppositely, just to raise the body from the ground, it would be no easier to thrust sideways than before. On the contrary, were a slighter elastic, as representing a lesser attraction, to replace the stouter, the resistance would be less. Inertia, I might here add, is in a philosophical sense simply the counterpart of force; it is that without which force would be absolutely ineffective, nay, without which it could not properly be conceived. Hence, although the literal meaning of the term is simply "doing nothing," what it denotes may quite consistently be viewed from the positive side, and be taken as a certain quantity.

To turn now to the motion of projectiles and the paths traced by bodies in free flight, it naturally follows from what has been advanced above that I should take some exception to the standard explana-

tion of these cases, inasmuch as it is based upon the idea that motion is originally unconditional and keeps up of itself. It is assumed as an axiom, namely, in accounting for any trajectory, that, resistance apart, the force of projection would send the missile on in a straight line at a uniform rate interminably, were not the force of gravity to deflect it. As a matter of analysis this answers sufficiently well; but to think that in reality the two forces can be divorced in any such way is a great mistake. Indeed it depends directly on gravity how the force of projection shall tell; and were that influence absent, I think that a force of projection, instead of being able to send its charge to infinity, would be altogether ineffective, not being in a position to give the body any way. The only reason why, under theoretical conditions, a projectile covers equal lateral sections in equal times, and in so far appears unaffected by the force that causes it to fall, is that gravity remains constant all the while; it is because the motion takes place at a given level on a globe that remains as it is. But supposing now that while a cannon ball were speeding along above it, the earth were by some miracle to lose half its substance, what then? Would the force of projection continue to carry on the moving body uniformly during this flight? I am convinced that it would not, and that the change would reduce the speed, even though no impressed force had been brought to bear against the missile, according to the provisions of the First Law. In fine, examination shows that the force of projection borrows its whole effectiveness from the play of gravity, and that a body

can only keep on travelling at a given speed where there is this influence to allow it. To regard gravitation, then, as a mere interference disturbing an otherwise perfect course, straight and uniform, due to the force of projection, is a false view; for in dispensing with gravity, the force of projection renders itself impotent, commits a kind of suicide. That perfect course, on the contrary is purely formal: it may indeed be conceived, but is far from being rationally realizable, since that which it is proposed to make inoperative in order to insure the regularity, namely the force of gravity, is itself indispensable to free motion of any kind.

The heavenly bodies in our system are in their way no more than giant projectiles, and their orbits are explained on the same composite principle. My objection consequently will also apply in their case. Were not the moon, it is said, constantly deflected, it would go straight on in one path at the same rate interminably; out of this path, however, the earth's attraction is constantly bending it, and so its course becomes almost circular. This account, now, assumes that of the two component motions the tangential maintains itself automatically, without requiring a constant cause or condition of things, whereas the motion at right angles to it cannot thus go on of itself, but requires the continuous exercise of a force. At bottom this distinction is unwarranted. Admittedly at any moment the moon also tends to fall straight to the earth, and unless deflected by some force sideways, would do so. If we ask about this force, we are referred to a cause that acted ages ago "in the

beginning," that being deemed sufficient. But if it were wholly sufficient, it seems to me that there would be no need for a direct and continuously acting force in the second direction either; for, on the same reckoning, an initial fall, like the initial projection, might as well suffice forever. The statement, then that gravity is constantly preventing the planets and satellites from breaking off at a tangent must be regarded as an analytical half-truth which ought either to be balanced by the complementary view that the same power acting indirectly is constantly maintaining their go, and would itself be a condition of their breaking away, or else be put in such a sense as no longer to suggest that while one of the component motions is automatic and everlasting, the other needs to be continuously occasioned. In abstracting from gravity, it ought to be recognized, we abstract in effect from momentum; in removing the deflecting force we remove the on-going, until a zero point is reached where, gravity being nil, unconstrained motion is entirely suspended.

The illustration of the sling, often adduced to bear out the case of the planetary motions as at present accounted for, is really no criterion. With a sling the body held does not derive its weight from the influence of the centre round which it is being twirled; hence, when loosened, there is nothing to coerce it to that centre, and it flies off at a tangent, thanks to the earth lending it weight, and so enabling it to carry. If anyone imagines that the same would happen in empty space, with no other mass acting on that of the body manipulated, I think he is much mistaken. But

here again, in order to test the matter, I am obliged to have recourse to a hypothetical instance. According to the accepted explanation, the earth's velocity in orbit is an independent and automatic affair; in so far, I mean, as it is said that that speed would be maintained indefinitely in the same direction, were it not for the deflection of gravity, which draws the body into a curved course. Upon this supposition, if part of the sun were suddenly to be annihilated, the earth ought to be deflected less, and describe a wider curve, flying out from its present path. Now I am open to correction, but it appears to me that in the event imagined, velocity would be reduced in accordance with the reduced attraction; so that the lesser momentum precisely meeting the lesser deflection, the earth's orbit would remain as before, though its period would be lengthened. This conclusion might be enforced by the following consideration. The centrifugal force which as it were holds a planet out as it goes round and round is recognized as being equal and opposite to gravity. When, then, gravity is reduced by an annihilation such as I have figured, centrifugal force, as the reverse aspect of the same stress, will concurrently and correspondingly be reduced also, leaving the body under attraction to pursue its former course: but this, according to well-known laws, it must then do at a lesser speed. If I am right in this, we here have a case in which motion is retarded, not by any resistance or imposition of force, but by its withdrawal; for though indeed matter, as inert, cannot retard itself, it might conceivably be retarded by the

lessening of that force which, as inert once again, it must be under to retain any given motion. In short, while others have assumed that motion can only be spent by some positive cause, as that of friction, air resistance, shock, and so on, logic has compelled me to assume that it might also be reduced or stopped by simple privation. Of course it is highly unnatural to suppose an annihilation of matter, but theory ought no less to take account of it than of an annihilation of gravity. Perhaps, if we looked at things in a simpler way, I might not have had occasion to go so far; for really the mere fact that a planet loses way in receding from the sun, and gains way in approaching it, is as direct a proof as we could have that motion is, not crossed and counteracted, but conserved by gravity; and that in truth gravity is the sole mediator in the case. But having coolly removed this animating principle as a mere interloper, people then claim that there would be perfect motion.

This instance of the earth losing speed in its revolution is at bottom simply a variation upon that of the cannon ball; for the latter body too, while travelling above ground, may be regarded as forming temporarily a kind of lesser planet. In thinking over the issue these cases raised, and in casting about to confirm my conclusion, I hit upon an observation which, even should it lend me no weight, will deserve to be mentioned for its prettiness. It is that if a body were dropped from a given height above the earth, and the time of its fall taken by a pendulum clock; and if then the body were dropped from the same height above some other planet and the fall were timed

by the same clock taken to that other planet, the clock would mark the same time for either fall, since the greater or lesser gravity that makes the body fall quicker or slower on the second planet quickens or retards the clock beats in proportion. The same would happen were a pendulum timing our cannon ball's flight, and whether the earth remained as it was or lost part of its substance during the flight, the clock would mark the same time for it; but in the event of the loss, we know that the clock would have been going slower; and hence the flight, following it, must also have been retarded.

While I am as certain as possible that the velocity of a perfectly free body might thus be retarded or stopped by privation, it is clear to my mind that that of a supported body would not be influenced except by a total cessation of gravitational play. To put this point at once into concrete form, I judge that if, while a fly-wheel were running under its own weight, or a bowl travelling along the ground, both free from friction as premised, the earth were then suddenly to lose its core, neither motion would be in the least altered—at least, as locally reckoned. The bodies being here supported, gravity cannot tell on them directly, and they consequently run on as before, the reduction simply affecting the degree of ease with which they might be stopped. This is also seen in the fact that the axial rotation of the heavenly bodies is absolutely uniform; not becoming slower as the body withdraws from its primary, or quickening in the opposite case, but remaining the same under all changes in the gravitational conditions; for these

bodies are more or less rigid, and their particles are not rotating in positive freedom, but under the constraint imposed by their conjunction with other particles. We might say that in these instances gravity is in so far rendered latent, whereas with a body freely in motion it is active; so that while in the first case a reduction of gravity has no ostensible effect, in the second it results in loss of speed. Yet though the influence of gravity might become exceedingly small without disturbing formal motion of this supported kind, it is evident that it could not quite vanish and still allow the motion to go on, for that would do away with the support. To remove part of its substance is equivalent to the removal of so much energy from a system, such is the subtle connection between matter and spirit; at length, when we have abstracted all but a single unit, and have only one rigid body, there is effectually no energy left, as there can then be no interplay: in this situation motion necessarily fails; it cannot even be started, much less can it be kept up. To embody these various issues in one illustration, I infer that, were all neighbouring bodies suddenly annihilated, a planet, instead of going straight on in its last direction at the same rate interminably, would on the contrary, not only at once stop on its course, but cease spinning as well.

I now add some detached remarks bearing in various ways on the general question: In contradistinction to the "impressed force" of gravity, centrifugal force is sometimes described as one exerted by the revolving body itself in virtue of its inertia. This is giving an active sense to "doing nothing," which, however, is

not necessarily inconsistent, as I have explained. To understand this paradox it is useful to consider the circumstances of the case as it were statically. We know that it requires no ostensible force to make a ball drop to the ground ; we merely have to liberate it, and it falls. Requiring no ostensible force, the ball offers no ostensible resistance ; it does not draw back from falling. When, however, compelled by other considerations, we find it necessary to introduce the notion of force, we are obliged to add its counterpart, that of resistance. In this view, a body needs to be dragged to the ground, and so by implication resists being dragged, or the force could not employ itself. The more the matter, the more it resists being carried to the ground, or it would not require the greater force that makes it fall at the same rate as less matter. I mean this, that the greater pull operating on a ton weight, that it may fall as quickly as a grain of sand, must be conceived as encountering greater opposition, else it would be superfluous, and would not come into play ; hence, in a gravitational regard, the more substantial the thing, the more it resists being made to fall. This is the aspect, then, in which a body's inertia may be imagined as a certain sort of activity ; and we need to conceive it so in order that there may be the requisite tension on the thing forced. Centrifugal force, as I say, is this same opposition, this same inertia or slovenliness, considered dynamically. Inasmuch now as this condition in the active sense only obtains because and so long as its counterpart, some force, does, we may figure how in the absence of any gravitational force it naturally falls away, and how

as a consequence the inertia of an isolated body can no longer effectively tell in keeping it in motion. A body of course does not do any more to keep in motion than to keep at rest; it is passive in either case; but that its inactivity may have effect in motion, it is necessary that the body be under some force, so that, tension ensuing, its sluggishness may be turned to active account. But failing this stress to bring it into play, a body's inertia cannot make itself good in counteraction: it becomes absolute, leaving the body no tendency to break away and to keep on getting out of places; so in pure default motion ceases, giving way to what is unconditionally and in every regard a staying or state.

Tremendous as Newton's conception was, it yet appears to have been partial in this, that it did not trouble about motion itself and the occasion of it, but substantially only about the direction and rate of motion. He seems to have asked himself why, in falling, a thing should go in that particular direction at that particular speed, and in answer to have concluded that certain forces must act to give such direction and velocity. But there is something prior to direction and speed, and that is the motion itself barely; having regard to this, we in our turn must ask ourselves, when we see anything moving along by itself, why it should keep up at all, no matter whither or how fast it is going; and must also conclude that certain conditions are necessary. How motion is initiated and given direction is evident enough; but in virtue of what does it continue—under the mediation of what is it that the ball that I

struck an instant ago still rolls on? In truth, I know no more than I know whence or what the force is in virtue of which I can strike out with my fist. All I can say is that an attraction, an influence, must be operating that a body may be in motion by itself, whatever the direction or the speed; I cannot explain the action, I cannot explain the force of gravity, though I see that it is involved.

There is certainly something rather occult and mysterious in the thought that, were we to roll a ball along on another planet, its motion would be totally different, even though we used the same exertion, or a different, in sending it off. In conceiving this it is brought home to us how little, in setting a thing in motion, we are the cause of what ensues; we see almost with amazement that the run of the ball is after all strictly governed by some hidden principle, acting as it were in despite of our preliminary thrust; we find in fact that this application of force has merely a temporary effect, and that we can only give a body motion in so far as conditions allow. It really is a great pity that we cannot go to the moon to gain a first-hand experience in these things; for failing it we are apt to over-estimate the part that the merely initiatory cause plays in motion, yes, and even to think it the only necessary factor. That it requires less initial velocity to carry a stone to a given height on Mars than to that height on the earth is easily conceived; but we do not perhaps consider that this will make the times of the ascents differ. If, on the other hand, the times agree, the heights or distances must differ; and if again, the initial velocities are the

same, then both distances and times will vary. Hence, no matter how started, two bodies on or about different planets could never be made to maintain similar velocities, to keep abreast of one another, in unassisted motion. I mention these particulars, not so much to prove my point, as to vivify and give the abstract fact an ocular existence in the imagination; for science, to be sure, would account for them by saying that different gravities differently disturb any given initial motion, still harping upon the ideal of an automatic uniform motion in a straight line, impeded or modified by gravity. We, on the contrary, are here conceiving the force of gravity, not thus as a mere negative principle, spoiling some prearranged course, but as actively supporting and inspiring all free motion; in a word, as the positive and animating principle. Taking the extreme instance, it does perhaps seem paradoxical that gravity, which is never thought of but as pulling things down, should alone enable a missile to be thrown upwards. Nevertheless, that it is most essentially concerned here may be realized by considering that without gravity the missile would be imponderous, in which condition it would go as far as the arm took it with the utmost imaginable ease, but could not be given any way, any impetus, to continue in motion by itself.

That the first law of motion as it now stands has never been seriously challenged will show that it sufficiently answers all practical purposes: in the letter at any rate it can hardly be inaccurate. Yet, having now carefully examined the salient points, I

shall presume to say that in spirit and fundamentally it is wrong, not having been framed on a strictly comprehensive appreciation of the facts. To be sure, matter, as inert, cannot stop or turn itself; but then, as inert, neither can it shift itself from place to place, that is to say, continue in motion of itself; it must be conditioned to do so. The stopping of motion is one thing, the maintaining of it another. But we ignore this circumstance entirely if we look upon the mysterious action that there is between every two particles of matter simply as a deflector of motion, and not also as the sustainer of it, as the one thing that renders true motion possible. Without this intermediary we could push and shift a thing from place to place, but set in it free self-motion never.

The received axiom, now, might be made to cover such considerations as these by tinkering; for example, by the addition of the words "or by privation of force" after "impressed forces." Yet as the whole statement seems to have been drawn up under a distinct misunderstanding, I think that it ought rather to be entirely recast. It would be best probably to split up the law, dealing first with positive rest, and afterwards with uniform motion in a straight line, which is a species of rest in one respect, but in another a continuous alteration requiring to be caused. For something is needed to show that there cannot be this state or maintenance of motion, which is so lightly assumed, except under play of gravity, and thence that a body cannot travel where there is no other body's mass to make its own

effective. This having first been made clear, it could then be added how in its turn the subordinate kind of uniformity concerning pace and direction, once the conditions were set for it, also required some positive cause, some external force, to break it, just as the absolute uniformity of rest did.

In a nutshell the question that I raise is this:—Whether, without some second body to attract it, a body could be put in movement at all, could be endowed with motion of its own. For, after all, though I have felt fairly sure of my ground, I will still admit that the matter may be a question. And that the decision is not easy, and cannot be come to off-hand, I am almost uncomfortably reminded by the length to which this study of the subject is running, or rather—that I may conclude it, if summarily, then in time—has run.

## The Planetary Distances

—Good onset 'bodes' good end.—*Spenser.*

THE various numerical series fabricated to agree more or less with the distances of the planets, and other similar feats designed to bring out some coincidence in their periods, mean motions, or the like, may one and all be viewed as tentative, though disguised and very distant, approaches to the solution of this underlying problem: Whether planets are ranged away from their primaries with any regularity; and if so, in what way and for what cause? In themselves I think these attempts are bad, because they are none of them conceived in a genuine spirit of inquiry, but are evidently made for display. Nevertheless, for what they darkly hint at, for their bare suggestion that there may perhaps be some law or other in the case, they are serviceable, and, if only in a negative degree, will repay some analysis.

The best known of these coincidences is that going by the name of Bode's Law. Like some venerable heirloom, it has descended from generation to generation for some time now without ever having been put to strict examination. It is described as an arithmetical relation subsisting between the distances

of the planets from the sun, the figures being as follows :—

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Geometrical series— | 0 | 3 | 6 | 12 | 24 | 48 | 96 | 192 | 384 |
| Add fours— | 4 | 7 | 10 | 16 | 28 | 52 | 100 | 196 | 388 |
| | Mercury | Venus | Earth | Mars | Ceres | Jupiter | Saturn | Uranus | Neptune |
| Actual Distances: Earth as 10— | 3·87 | 7·23 | 10·00 | 15·23 | 27·66 | 52·03 | 95·4 | 191·8 | 300·4 |
| Saturn as 100— | 4·05 | 7·59 | 10·48 | 15·97 | 29·01 | 54·55 | 100·0 | 201·1 | 315·1 |
| Neptune as 388— | 4·99 | 9·33 | 12·90 | 19·67 | 35·72 | 67·16 | 123·1 | 247·6 | 388·0 |

This table is more complete than those given elsewhere, in that it takes alternative planets for standards of comparison. This is a particular of some importance ; for there is no reason whatever to assume that the earth is the chosen one of all the planets to be just at the right distance. Perhaps Saturn or Neptune may be more regularly placed : how are we to know in advance ? Of course, with any genuine formula, such an interchange of standards ought to make no difference, as the distances are always proportionately the same. That it does make a difference in Bode's Law is therefore suspicious.

A still more objectionable feature in Bode's Law is the arbitrary addition to the series. Look at this manœuvre how we will, it is perfectly unjustifiable : it is in fact a pure trick, the fours being spirited into the calculation much as a conjuror might slip an extra complement of aces into a pack of cards before dealing out some surprising combination. This will be readily understood if we consider that while equals added to equals give equals, equals added to proportionals make disproportionals ; so that if by

some dexterous addition of this sort we are able to show a correspondence between the series and the planetary distances, it will prove that there is a disproportion in these distances, which is in effect the case. It is easy to see that the result of adding a small quantity to a geometrical series must be to make an exaggerated difference among the lower numbers, but hardly to alter the higher at all. Thus by adding 4 to 1 and 2, I make the proportion as 1 to 1·2; but adding the same to 32 and 64, I make the proportion as 1 to 1·9—that is, I make fifty per cent difference in treating exactly the same ratio. This subterfuge is very neatly made use of in Bode's arrangement so as to meet the peculiar exigencies of the case; for it happens to be just at the beginning of the series that the assumed double-distance proportion most requires to be toned down, the distances of the earth and Mars in particular being much away from that normal.

Putting aside this obvious manipulation, then, as a trick, we find that what Bode's Law really affirms is that each planet is at double the distance of the inferior one. And that is an affirmation not supported by the facts. This will be best appreciated by a glance at the following table, in which the distances are given in terms of the next inferior planet's distance, or the figures of which, in other words, show how many times further distant from the sun is any planet than the preceding. According to the substance of Bode's Law, this multiplier should be 2 in each instance; while by the irregular device of addition it becomes a variable quantity

with a diminishing rate of increase, but remaining indefinitely just below 2.

| | | Merc. | Venus | Earth | Mars | Planetoids | Jupiter | Saturn | Uranus | Neptune |
|---|---|---|---|---|---|---|---|---|---|---|
| Bode's Law | As implied :— | ... | 2·00 | 2·00 | 2·00 | 2·00 | 2·00 | 2·00 | 2·00 | 2·00 |
| | As manipulated :— | ... | 1·75 | 1·43 | 1·60 | 1·75 | 1·86 | 1·92 | 1·96 | 1·98 |
| | Actual Distances :— | ... | 1·87 | 1·38 | 1·52 | 1·83 | 1·86 | 1·83 | 2·01 | 1·57 |

For analytical purposes this method of calculating the planetary distances is much the best; for any correspondence or proportion would at once be disclosed by it. Bode's Law stands this test very badly, and it is in fact shown to be erroneous in conception as in execution. The assumption of the manipulated series, for instance, that the distances follow multipliers rising rapidly from $1\frac{1}{2}$ to near 2, is wrong. As to the true import of the law, and its insinuation that the distances double one another outwards, matters are even worse. Only a single planet, Uranus, approximately answers the rule, all the rest falling more or less short; and, ironically enough, the earth's distance, which in Bode's arrangement is adopted as a standard of precision, shows the greatest deviation of any, the planet being only one and a third times Venus' distance. And it must be remembered that fractional differences here may represent an error of many millions of miles.

Text books on astronomy and works of reference invariably single out Neptune as the great exception to Bode's Law. But this is only so upon a superficial view of the case; for both the earth and Mars, as well as a number of individual planetoids, if we are to include them, are further from the proposed normal of double distances than is Neptune; while of the whole suite of planets, as it appears, Uranus is

the only one really to fit in with the theory. The reason why the matter is not seen in this light is simply that Bode's Law has always been accepted at its face value; whereas here it is handled according to its intrinsic value, its actual purport. This results in a veritable exposé, as is seen in the accompanying table.

Of other coincidences having Bode's Law for their model, it is enough to say that they do not come up to their original. There remains, however, a further species of the order, the attempt of which is to produce a correspondence between the motions or longitudes of selected satellites by means of a certain more or less legitimate manipulation. The prize example of this kind is one as amazing as it is famous, and concerns Jupiter's first three chief satellites. The figures may be introduced here for reference.

| | | | |
|---|---|---|---|
| Mean daily motion of Jupiter's | I. = 203°·4890 taken once | 203°·4890 | |
| ,, ,, ,, ,, ,, | III. = 50°·3177 taken twice | 100°·6354 | —304°·1244 |
| ,, ,, ,, ,, ,, | II. = 101°·3748 taken thrice | | —304°·1244 |

This method of adding the first quantity to twice the third, and so equalizing it with three times the second, may be compared to an irregular kind of averaging. Now all averages are open to this objection, that as regards particular truth they give a false representation. We have, for instance, in these three periods, three quantities nearly in geometrical progression; but exactly in that progression they are not, and no manipulation of figures will ever make them in fact so. Besides, if we are allowed to

add and multiply as the fancy takes us, the most heterogeneous elements may be brought into apparent agreement. For example, instead of these three mean motions standing nearly as 4, 2, 1, we might have three standing say as 43, 7, 1, and then pretend to find some occult coincidence because the first added to six times the last is exactly equal to seven times the second. This applies more especially to the following complicated Saturnian relation.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 5 times the mean motion of Saturn's | 1st | satellite | equals | | | | | 1911°·0 |
| 1 time | ,, | ,, | ,, | ,, | ,, | 3rd | ,, | ,, | 190°·7 |
| 4 times | ,, | ,, | ,, | ,, | ,, | 4th | ,, | ,, | 526°·6 = 2627°·3 |
| added = 10 times | ,, | ,, | ,, | ,, | ,, | 2nd | ,, | ,, | = 2627°·4 |

Compared with that of the previous example, the coincidence here is trouvé and unduly forced. In a geometrical decreasing series the first quantity added to twice the third does equal three times the second; so that in this case the equality arrived at seems to show that excess and defect in the motions are in some way counterbalanced. But the third number added to five times the first and four times the fourth does not equal ten times the second, and therefore that the sums are made to agree in this Saturnian composition only proves that the satellites in question are not regularly arranged.

It is to be added that calculations of this particular kind, and all in fact seeking for near approaches to commensurability of periods, are not a little perverse in their aims, seeing that the perfect proportions they strive to arrange for are known in advance to be mechanically impossible. If these planetary times could be resolved so exactly into one another, they

would be in the relation of whole numbers; but then in that case, as physical astronomy informs us, permanent disturbances would take place, resulting in change of orbit. The precise correspondence, therefore, that these calculations endeavour by hook or by crook to produce is the very last thing we should expect actually to obtain in the reality of the case they deal with. Still, on the other hand, it may certainly be said in defence that, in the capacity of averages, such manipulations are useful in bringing into relief some general tendency. The distances or periods are not in fact regular, but the averaging shows that they tended perhaps to be so; implies that had the conditions been uniform, the results would have been uniform, or even that an exact correspondence did at one time actually exist, but has since been disturbed. In this case, however, the process we employ ought to be sufficiently analyzed, so that we may recognize what our addings and multiplyings really amount to. For science aims to know, not to produce amazement. Care should therefore be taken not to stop at what is merely striking, as if that were the end: one ought to penetrate as far as possible into the reason and meaning of the thing.

When we wish to get to the bottom of any question, nothing is more useful than to collect all the facts, and to consider them just as they are. This plan is so obvious that to follow it is almost an innovation. A great deal, however, depends on how the facts are presented. In astronomical tables the distances of the planets and their satellites are of course always given in terms of some definite unit, as the mile, the

| .339 gives Oberon's.] | | | Mean Multiplier | |
|---|---|---|---|---|
| Uranus | Neptune | | Unmodified | Selected |
| T<br>·011 | 1·567 | | 1·723 | E. & M. in one<br>1·863 |
| II<br>J | VIII | | | |
| 122 | 3·053 | | 2·125 | (first four)<br>1·795 |
| ion | Japetus | Phoebe | | |
| S<br>18 | 2·376 | 3·609 | 1·531 | (first ten)<br>1·345 |
| U | | | 1·452 | |
| | | | 2·498 | |
| Missing Satellite | VIII | | | |
| (( 1·755 | 1·755 | | 1·797 | |
| | Phoebe | | | |
| (( | 1·534 | | 1·406 | |

To face page 37.

kilometre, a body's radius, distance, or what not. In so far they are absolute tables, and do not, on the face of it, show any general correspondence that may subsist, either between the various members of a system, or between the systems themselves. Under these circumstances I am subjoining a special table, entirely relative in character. The unit here employed is itself relative, being "the preceding planet's distance"; so that all quantities will necessarily be taken in conjunction with others, and a properly comparative view of the whole obtained. By these means too, the particular planetary systems will be brought into correct focus with the solar system, to which, though quantitatively so disproportionate, they are nevertheless qualitatively or essentially so nearly parallel. Somewhat as Mercator in his "Projection" made a valuable contribution to geography by the simple re-arrangement of materials already available in other settings, so perhaps, in a minor degree, I may claim in this table to have recast certain common facts of astronomy in an especially serviceable and significant form. At any rate, I know that its burden is more informing and more deserving of study than anything I can say about it; for while the main figures keep sternly to fact, my comment must hazard conjecture.

The principal point brought out by this table is that the formation of attendant bodies about a central body consists in what is essentially one and the same process repeated on a constantly altering scale. It shows us, for instance, that the earth is situated with regard to Venus exactly as in the

minor system of Uranus, Umbriel is to Ariel; and how, therefore, the nebulous rings from which, supposedly, these two bodies formed must have broken away from their respective nuclei at a precisely corresponding point, notwithstanding that the one operation was being carried out upon a scale nearly five hundred times greater than the other. This, it is true, is a selected example, and might, of course, be counterbalanced by others showing considerable disparity; but no one would expect to find planetary systems forming on absolutely invariable lines; and the remarkable general correspondence disclosed by the table is, therefore, highly significant. It means, as I say, that in the problem of distances we have to deal with but one phenomenon manifolded on various scales, the fractional differences evidently being brought about by irregularity in the density gradients. This phenomenon is the liberation of a ring from a nebulous mass, and the question about it is why the nebula should break at a particular point, and what circumstances would cause variations in the breaking point. These are mechanical questions, in themselves, one would suppose, of little difficulty; and though the answering of them would not enable us to account in full detail for the station of the planets, or to predict with complete accuracy where still missing bodies might be found, it would take the matter out of the sphere of haphazard empiricism and coincidence-making, and place it on a scientific basis. On account of incalculable contingencies, we cannot perhaps figure to ourselves exactly how the present arrangement evolved; but it ought, at least,

to be possible for us to determine how an ideal planetary system would form, just as we determine how the ideal pendulum acts. Now, there is nothing in nature exactly answering the simple pendulum, and yet the principles of it do, with the necessary modifications, apply to actual pendulums; and so no less, then, in calculating what would result under ideal circumstances in this other case, should we be laying down the true theory and law of planetary distances, notwithstanding that Jupiter or Mars, or any of the other members did not immediately answer to it. However crude it might be, such a law would really deserve the name, and not merely masquerade under it as, in default of anything better, Bode's Law now does. Still, I must not forget that the Bode figures indirectly led to the discovery of the planetoids. This, at any rate, is a happy achievement in which they are deserving of imitation.

In considering the discovery that I mention, it is easily seen that the deduction following which a search was made for the supposedly missing planet did not depend on any special device embodied in Bode's Law, but could have been arrived at by a direct comparison of the planetary distances. That was all that was needed, once the idea of a certain systemization in the intervals had been entertained. It is exactly the same in the present instance: the figures, just as they are, speak for themselves, and leave theory to hobble after, like travellers who have made known their wants by dumbshow before the interpreter has arrived to lend them formal expression. Anyone can see, for instance, that Jupiter's

sixth satellite is altogether exceptionally situated, its distance being no less than six times the preceding—a jump without parallel, or even approach, in the whole range of planetary localization. It is as if in the case of the major planets, Saturn were the next superior to Mars. So gross a disparity points emphatically to the presence of an undetected satellite between the fourth and sixth; and in my own opinion even two ought to be occupying this abnormally big interval. What supports this conjecture is that if we take the mean of the previous multipliers (up to Jupiter IV.) to place these hypothetical satellites, the result accords very nearly with the given distance of Jupiter's VI.: in other words, this mean closely approximates to the third root of the abnormal multiplier, thus suggesting that the latter is really a composite one allowing for two regularly placed extra satellites. More; in carrying on the calculation with the same mean, the second step brings us almost exactly to the distance of Jupiter's recently discovered eighth satellite; so that, considering how disproportionate is the interval here, I do not hesitate to predict a third extra satellite for Jupiter, circulating between the present VII. and VIII. On this reckoning, the three missing satellites ought to be at distances respectively of 3·5, 6·4, and 20·4 million kilometres from their primary. To be sure, there would be irregularity in this very regularity; for along with the general agreement there runs great variety in particular; nevertheless, at these distances, there or thereabouts, some satellite assuredly remains to be discovered Indeed,

that at least one additional Jovian member is extant amounts to a moral certainty, and a systematic search in these regions ought therefore at once to be instituted. Probable as it was, for instance, that the zone between Mars and Jupiter should be occupied, it is mathematically just twice as probable that some inhabitant lurks in that between Jupiter's IV. and VI. It is not crying "wolf," then, to urge astronomers by all means to attempt to track down a body here. Of course, the missing satellite is sure to be a relatively small one, but the difficulties this imposes ought to be largely discounted by the fact that pains spent in trying to locate it are so likely to be rewarded.

In view of its great distance from the primary, as I may mention while speaking of Jupiter, it has been suggested that that planet's eighth member is in reality a comet captured, as it were, in the Jovian net of attraction. This is not borne out by our figures; for comparatively it is not nearly at so exceptional a distance as is Moon VI., and beyond this fits in most systematically with a series computed according to an average given us by the nearer satellites. It is, therefore, undoubtedly a genuine offspring of Jupiter.

If not to the same marked extent, Saturn's figures also show several discrepancies. From Rhea to Titan is an unusual spring; but this is almost compensated by the proximity of the two following moons. Japetus, however, and still more Phoebe, are so disproportionately placed as strongly to hint at the presence of additional satellites in their neighbourhood.

Though feeling myself on less sure ground than in the case of Jupiter, I have, therefore, constructed a conjectural arrangement indicating the position of three satellites still possibly to be credited to Saturn. The distances are taken as 2·3, 5·4, and 8·3 million kilometres from the parent body. It will be noticed that I include Saturn's rings in its train of attendants. They may not, it is true, be incipient satellites, but they form, at least, a certain equivalent; and, as a matter of fact, the arrangement they are in is much of a piece with that of the following moons. I suppose, as far as this goes, that an ultimate collapse of these rings is not altogether out of the question. What a great event in nature it would be if that were to happen! All the telescopes in Christendom would be turned on Saturn, and people would be thrilled with superstitious wonder to think that they had assisted at the actual birth of a satellite, if it came to that. Yet the world would go on as before, and no one would eat any the less for supper.

With regard to the solar distances, the earth, Mars and Neptune are all a good deal out of proportion, especially when the symmetry of the remaining members is considered. Possible it might be that the earth and Mars evolved as twins from what was originally but one ring: by combining their figures we get a multiplier very close to that of Uranus.

All these conjectures and considerations are no no more than empirical: they are such as occur to one on the face of the matter, and, in fact, are only

removed from pure guesswork in that they credit nature with a certain uniformity, applying the principle, *natura non facit saltus.* I say this without prejudice, because it was some such bare comparison, without any further art, which led to the taking of those active and successful measures to which we owe the discovery of the planetoids—an end so prosperous that, adopting the means, we have endeavoured to imitate it in other directions. But after all it is the science of the thing that matters. Happy-go-lucky, superficial judgment stumbles at best upon some additional fact, leaving us essentially as much in the dark as before; whereas insight and understanding enrich us with the principle which becomes a key to all possible facts in its particular domain. To formulate such a principle in the present instance is certainly not easy; but, if it cannot be definitely settled, the abstract question ought at any rate to be discussed; for it is a serious omission that coincidences such as those quoted above respecting the Jupiter moons and the progression roughly brought out by Bode's Law should remain matters of curiosity, and never so much as an attempt be made to reduce them to shape of reason. Without promising that any great light will be thrown on the subject, I shall, therefore, now consider some of the points that seem to bear most nearly on the cause of the planetary distances.

The first and most apparent rule we notice in this connection is that intervals increase with distance from the parent body. To this there are a few exceptions, and even they are balanced by

some corresponding excess. Nay, they are so clearly exceptions that we can hardly conceive of a system forming under an opposite rule and having decreasing intervals from the centre outwards. But why would this be anomalous? Simply because, the whole evolution taking place round a centre, what occurs to the whole afterwards occurs to the part and the part of that part in a direction towards, and not away from, that controlling point. I say that the formation is brought about by a recurring operation in this way, because the table plainly shows that the distances at any rate tend to be in some sort of geometrical progression, a circumstance in my opinion implying the repetition of one single phase on a diminishing scale. For instance, if a uniform nebula split at half its radius, the same conditions continuing to prevail, the remainder would subsequently split at its half-radius, and so on, thus giving the positive series, 1, 2, 4, 8, etc., for the ring distances. But, in general, the same cause that makes a nebula part at a particular spot, also determines a nucleus to gather at a proportionate point in the ring; so that under uniform conditions planetary distances would be as ring distances or breaks, and vice versa. If, for instance, the breaks are at 0·5, 0·25, 0·125, etc., and the planets form at any proportionate point in them, as at their thirds or whatever it may be, then these planets' distances will also be as 0·5, 0·25, etc., among themselves. Hence in the ideal or regularly forming system breaks are as distances. Nor do I think there could in any actual system be much disparity between

these two, but surmise that where distances are irregular it must mainly depend on some corresponding ring irregularity rather than on difference of formation within duly proportionate rings; for both the ring and what forms from it evolve under the same gravitation.

Some theorists coolly propose to reform Laplace's hypothesis by doing away with the rings: it is doubtful, they say, whether portions of the nebula would separate as rings. This is like bettering a tree by cutting away its root; for the release of a series of rings is the specific and essential principle of the theory, the very point in virtue of which it constitutes a possible explanation of the origin of the solar system. Merely so as to fit in the backward rotations of Uranus and Neptune—quite a subordinate matter—La Faye, for example, would have it that the planets formed round chance points in the bosom of the nebula. But if this had been so, there would assuredly have been no rhyme or reason in the planetary distances: one body might easily have been twenty times the distance of the next nearer, and in short the various members would have been jumbled up at a venture. As it is, we find them in wonderfully regular progression, broadly considered; and this means method. Still, it is not to be denied that weighty objections can be brought against the ring assumption. The most pertinent, in my opinion, is that raised by Kirkwood, touching as it does upon the crux of the question. He argues that, because of the weakness of cohesion obtaining in so greatly diffused a mass as the nebula, the matter

separated by the growing centrifugal force must have been cast, not by rarely recurring efforts, but continually and fragmentarily. "Each wisp of nebula would have successively declared its independence, and the result would have been a meteoric, not a planetary system."

It appears to me that something of this nature did at first occur, but that its effect must have been simply to flatten the mass. Now if this flattening were to be carried so far as to leave the nebula to all intents and purposes a mere disc or plane, gravity would be automatically levelled within it, and the attraction be uniform and the same at all points, predicating the usual original homogeneity of the matter. Of course this could not altogether occur, but it would occur in part and in measure as there was a flattening; for that re-arrangement of the mass naturally reduces the gravity gradient "as the distance," which obtains within a globe. And this reduction, I conceive, might be completed dynamically by a rotation itself a little under the "as the distance" gradient on account of imperfect cohesion—a rotation, that is to say, dragging somewhat towards the edges. In some such way I figure to myself the centrifugal force overcoming gravity, not at the exterior of the mass only, but all along the line; when, simple leverage coming into play, the nebula would tend to split at a certain virtual half-way point. Were the mass altogether flat, this point would be mathematically at 0·707 of the radius, that is, at the half square-rooted; but on the hypothesis it is something between a globe

and a disc; so the figure will be a little higher, giving a corresponding distance-multiplier of about 1·3. Any preponderance of density towards the centre, such as would occur upon condensation, would of course shift this breaking point further inwards and proportionately increase the multiplier. For a break to occur at the actual half-radius, the density gradient would already have to be excessively steep; and indeed, as we see from our table, the corresponding multiplier of 2·0 is quite abnormal. Any figure much above this implies therefore, as I judge, one of two things: either that the planet in question has subsequently had its orbit expanded by tidal friction or some other special cause, or else that one or more undetected bodies intervene between it and its accredited inferior. On the other hand, I should set the minimum break at about 0·8 of the radius, this providing for a multiplier of 1·25. Where, as in the case of Themis and Jupiter's seventh satellite, we get a considerably smaller figure, it evidently means that two bodies have formed from the same ring. Between these extremes the mean will lie. According to the tabulated distances it is 1·718; and although this is an unmodified figure, and takes no account of any probable intermediate satellites or of twin formations, as these two possibilities balance each other, we may suppose it is not far from the eventual mean. Thus, what we arrive at by fact—I mean in averaging the distance relations as they actually are—quite agrees with what we arrived at upon theory; for we calculated that the critical

point in a much oblated spheroid of even density would be in the region of three-quarters of the radius, but that, allowing for the natural increase of density towards the centre, it would be shifted nearer in, giving figures, now slightly above, now slightly beneath, the empirical mean.

The theory here advanced I advance expressly as a crude one. For this reason I need not stop to criticize minor points in it. And if anyone else should feel inclined to do so, I should advise him rather to attack the problem itself, and tell how and why a nebula splits between, say, 0·5 and 0·7 of its radius, instead of being dissipated in wisps from the edge, as Kirkwood suggests. My own opinion respecting this is that the gradients of attraction and centrifugal force, that is, their rates of increase with distance from the centre, are similar; so that when the one force counterbalances the other it does so at all points equally, thus leaving the mass to part along some virtual middle line, and duly abandon its ring. The idea that the nucleus would throw off its matter fragmentarily and continuously seems to be derived by false analogy from cases such as we meet with in ordinary experience, where, there being no attraction towards the centre of a small body, it is merely a matter of contention between centrifugal force and cohesion. But in our instance of a free nebula, the mass is held together almost entirely by gravitation; and so it is the combat between that and centrifugal force, and their respective gradations, which must primarily be considered. Under these conditions an automatic levelling takes place, until, just after the forces have

been exactly balanced, and the centrifugal tendency threatens to dissipate the mass at any and every point, the little cohesion that there is comes into operation, and gives its casting vote for a break at the point of equilibrium.

If this theory is at all correct, the various rings must, as Newcomb surmises, have divided from the main body almost simultaneously; that is to say, the nucleus left after the abandonment of the first ring would itself quickly re-split, not having to gain any extra speed to counteract gravity; for upon our supposition, once the centrifugal force neutralizes this at one point, it does so throughout. This, however, and the subsequent direction of rotation given to the planets, are questions that can well be left open, since it is not the whole nebular hypothesis we are studying, but one special phase in its bearing on the planetary distances.

I have been assuming here, it remains to be added, that the planetary distances have not changed in the course of time. They may have done so naturally; but not, I think, enough to obscure the original proportions or scheme, of the systems.

## The Negative Complementation of Colours

THOSE who imagine that white has any special precedence of black in virtue of its positive character would do well to consider this page of printing. It is the light, certainly, that has the effect on the eye; yet what we actually attend to in reading is the "mere negation," the darkness, inasmuch as the letters themselves are formed of it. In truth both qualities are equally concerned, since neither could be manifested without its counterpart.

Pursuing this turn of reasoning, and fortified in my conjectures by certain general rules of correlation, it occurred to me that black ought to be just as decomposable and recomposable as white is, and in fine that the truths bearing on the nature of white ought to be reversible. Nor must I be thought to be stretching a point in conceiving it logical to deal with black as a positive and composite effect. I do not indeed maintain that any direct action produces the darkness that we are aware of, say in an unlighted cellar; for that would be ridiculous. But the case is quite different when in place of this indefinite darkness a black surface is the object of attention. Suppose it is a black disc upon a piece of white paper that we are looking at, then I contend that the one effect is

as much due to a positive action as the other, the various rays which in the one case have to be reflected, in the other having severally to be absorbed: mere quiescence or negation does not produce this black, but there has to be a certain activity, so that the rays that fall upon the disc may not be sent back; there must be the active prevention. But one does not need to beat about to enforce this point, seeing that as an acknowledged example of black's composite nature there are the Fraunhofer lines themselves, the blackness of which results from a certain interaction of waves just as whiteness does, only that there is confliction in the former instance. I might notice here in addition that the black surface and the white even exchange functions. If the black surface did not in practice reflect a percentage of white, it could not be told to be a surface, but would appear permeable and void like mere darkness; and the white surface too must produce a modicum of black by partial non-reflection, or it also would seem to be liquid and intangible. In so far, we see, as these correlatives fail to manifest their own character, they manifest that of their opposites, and hence fall under one genus, the nature of which is to deal in either direction with all rays alike, and so to produce that totality the two aspects of which are white and black.

That a black streak may be resolved into colours by means of a prism as perfectly as a white one may, goes without saying. Yet there would certainly be some objection against calling the former transformation a decomposition of black, though that is what it virtually amounts to; for of course in either case it

is the rays from the white that undergo the separation. Still it must not be overlooked that the two factors are equally involved: the darkness is as indispensable as the light, since without the former no spectrum can be produced. This circumstance was made a special point of by the great Goethe, who thought it so significant that plain white looked at through a prism should undergo no decomposition, that he may be said to have built up his whole colour theory on this one observation. In effect, to obtain the single slip of light needed for manipulation, darkness must necessarily be called in as a helpmate.

The spectrum got by decomposing black is of course only an inversion of the common spectrum from white, but it deserves attention for this reason, that it brings together the "pure" end colours of the ordinary spectrum, and submits them to the characteristic dual modification. For I need hardly say that it is an arbitrary and not a natural arrangement that two colours so obviously related as the red and the violet do not appear as neighbours in the spectrum, but as poles. Nor is it natural either that the colour scale should proceed from and run into black, as we make it do; it should be set within colour indefinitely. In the same way as we best judge of the pattern of a wall-paper from several rolls, being then in a position to study the repeat; so I think that the spectrum ought to be examined, not as abruptly terminating in black or white, but in proper conjunction with bordering spectra. I imagine, for this purpose, a light-screen with two adjacent slits so adjusted as to form a continuous

band of colour. In this double spectrum the red portion would be studied as shown in the middle, not at the extremities. And indeed the junction of the colour-repeat at this point ought to yield some information as to the connection between the visible and invisible rays of the ordinary spectrum ; for from a purely philosophical point of view, these extrinsic rays would seem to be but the result of a disruption or unlapping of the essentially continuous colour band, and when again brought together so as to overlap, the heat rays on the one hand and the chemical rays on the other should concur to produce light.

These, however, are ideas but incidentally connected with our subject. Without further developing them, therefore, I now pass on to the matter of recomposition.

To show the composite character of white, and that as light it has rays of all refrangibilities, no method is at once more simple and popular than that making use of Newton's disc. Some exception, however, is occasionally taken to the experiment, it being often alleged that it does not produce a true white, but smudgy grey. For this, undoubtedly, the background that the disc is spun against has to answer, as a personal test will soon show. To get a clean white the disc must have a black border ; and it will still further heighten the effect if the card is given a dark centre, thus leaving a spectrum ring set in black.

To reverse this experiment ; to put the same colour annulus on a white mount in place of a black ;

to twirl the disc, and to have the colours merge into black as they previously did into white ;—all this is really so obvious and in such natural sequence, that I should have the greatest hesitation in claiming novelty and even importance for it, were it not for the fact that black has always been curtly dismissed as a mere negation. This prepossession has prevented people from duly appreciating the circumstance that each colour on the disc plays a double part, not only reflecting certain rays, but absorbing a chosen remainder. By mounting the spectrum ring, now on black, now on white, we are virtually enabled to separate these activities of reflection and absorption ; and it naturally follows that where the collective effect of the reflections gives white, that of the absorptions gives black, each colour here abstracting its assigned portion from that which before it contributed to make up, namely white light. This effect of recomposing black from the very range of colours used in Newton's disc with contrary intent is generally applicable, and any colour combination which produces white may also be made to produce black : it suffices to set them against the respective back-ground, as detailed.

The explanation of this phenomenon, I take to be that while a black border by force of contrast directs attention to the more luminous half of the spectrum, to which it most stands in opposition, the white bordering, on the contrary, emphasizes the less luminous half. It is, however, important to note that neither of these halves, however bordered, would by themselves give either white or black, but some

mongrel colour instead; for the whole range, or else a perfect complement, of colours is necessary to obtain that sum-total, the effect of which is either black or white. I therefore say, not that one bordering allows but one half of the colour-round to act, and the other bordering the other half, each in turn as it were suppressing a remainder (for these remainders are necessary constituents of the resulting black or white); but simply that by means of the bordering, attention is forced primarily to one pole or the other, and that this gives the note for the ensuing impression, and determines into which extreme it shall fall.

Every colour may be considered and valued from two opposite points of view: in regard to its luminosity, or in regard to its non-luminosity; for what it transmits, or for what it suppresses, of light. To obtain black in a strictly monochromatic light, it would only be necessary for rays of one single order to be absorbed; and under the circumstances, no further contrast being presented, their non-absorption would perforce constitute the "white." But where the light is composite, it is evident that just as a variety of rays has to be transmitted to give white, so equally must a variety be absorbed to give superficial black. Hence every colour pair is complementary in a double sense, the second colour not only bringing up the quantum of reflected light to the totality, white, but also absorbing a special qualitative remainder to complete the correlative totality, black. Thus, then, under varying circumstances, the combination of complementary colours will yield

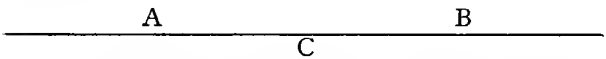
either black or white, as the case may be. And the spectrum being, at least potentially, an infinite number of such pairs or complements, the same applies to it as a whole, or to any combination approximately representing it as a whole.

This being so, we may easily figure to ourselves how the device of bordering, by its force of contrast, impresses the eye primarily in one of two directions; so that with this cue, it should seek from the complements the corresponding and culminating effect. Were this selection not led up to, nay, determined with the certainty of a reflex action, the brightness of one colour might as easily be counteracted as complemented by its opposite, and conversely with the dullness; which would lead to neither one extreme nor the other. As it is, then, when the combination is black-bordered, the eye is caught by the lighter constituents, and so set, in coming to the complements, views them, though essentially dark or absorptive, exclusively for what they reflect, thus raising the dominant previous impression to its totality, white. In the contrary case the initial and prevailing impression is of the darker constituents, and this so strikes the note for what is to ensue, that essentially bright colours are viewed merely for what they absorb, thus reinforcing and carrying on the original effect to its completion in black. In the former instance, the complement is made to supply the required quota in reflection; in the latter its contribution is in the form of absorption. Which of these two shall be drawn upon is determined by the mounting and the particular topic it introduces.

## The Principles of Correlation

SOME things and qualities differ altogether, as a taste from a spoon, or sleep from circularity; others differ in some collateral circumstance, as a fork from a spoon; while others again differ directly, in a polar sense, and are contraries. Things in the first of these categories cannot be compared; those in the second may be; those in the third must be—I mean, their very subsistence is comparative, and they obtain in no other way than by reason of one another. The fact itself that contraries are so exactly opposed, one of the pair being the other turned over, gives them some common point, which in so far allies and indissolubly binds them. Nothing, we know, could possibly be more opposed to white than black; and yet there is that connection between them which renders them less diverse, less foreign from one another, than say white and flexibility—things totally apart and of different orders. For, indeed, as together making up a genus, correlatives cannot of course be generically distinct; they do not differ at bottom in kind, but in position rather; we even express so much in saying that the opposition is "diametrical."

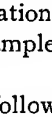
This last circumstance enables, and sanctions, us to some extent to treat our subject geometrically, and thus to predicate certain things of all that comes under the essential form of simple correlation. The form in question is represented by a straight line of indefinite length, which gives, on the one hand, two directions and their opposition; and on the other hand, a fundamental unity and inseparability, both characteristic of correlation and involved in it. The letters I place along this line will stand, not so much for definite points, as for indeterminate regions or districts.




In considering this model of correlation it is easy to see how from the exigencies of the case two regions, A and B, mutually determine one another; for a single spot, without any further reference, can have no particular situation upon an indefinite line. Hence A is only the region it is in reference to B, and conversely, each necessarily involving the other. Correlatives are exactly in this position; they serve to define, and in every case mutually involve one another; neither can ever be quite independent. A simple matter, the reader will say, and I agree. But if the force and validity of the rule were really recognized, how could there ever be any doubt on a question, for instance, of this sort: Whether, if all conscious beings were destroyed, there would still be a world, or no? Were the form of correlation present to anyone wishing to settle such a point, he

would see at once that, subject and object falling under it, the destruction of the one necessarily involved that of the other. I give this as a case in point, but the rule applies universally, that is, to all correlatives. It is a matter of definition, for a thing could never be discerned unless set against some other. With correlatives the set-off is such as to be diametrical, the opposites forming and exhausting one genus, or whole. I might mention here as regards this whole, that it sometimes has a name composed from those of the two opposing parts, sometimes one taken from that of one of the parts, sometimes a separate name, and very frequently no name at all. Examples of the first sort are tragi-comedy, chiaroscuro; of the second, length, as that which long and short have to do with, or mankind, covering man and woman; of the third, temperature, as a genus formed by hot and cold, or weight, as formed by light and heavy; while with correlatives like mind and matter, absolute and relative, it is difficult to name what they are one in, what totality they make up.

The next thing that may be definitely predicated of correlatives is that any distinction made between the two as being, one positive, and the other negative must be purely conventional. Philosophically, or in the bare nature of the thing, there is no priority in the case, since that would do away with the strict reciprocity. Hence either extreme may in turn be regarded as the positive. This will at once be manifest if we turn to the form of correlation, when we shall clearly perceive that A is no more not-B

than B is not-A. This point, however, I have treated at length in a former work of mine, and need not go further into here. In that place, moreover, the nature of the media developed by correlatives was criticized; and it was shown that the medium could never have the same positive status as the extremes, being something essentially provisional. Were the medium as distinct from either extreme as they from one another, correlation would have to be illustrated in the form of a three-spoked star, thus: 

instead of by the indefinite straight line we find actually indicative of the relation. The A, B, C, here would stand, for example, for hot, cold, and temperate.

It seems to me also to follow from the form of correlation that we cannot in the nature of the case ever meet with an extreme in perfect purity; or, in other words, that we cannot reach the extreme itself However far away it may be put, the A. end runs into the B. end; so that at any point there is always a certain commixture. This statement will require some qualification, but I will first give a few instances showing how it does apply. Hydrogen is extremely rare, osmium extremely dense, the diamond extremely hard, and light extremely swift; but, assuming these for argument's sake to be the experimental maxima in their respective kinds, we see that it would be perfectly unwarrantable to assert that nothing could possibly be rarer, denser, harder, or swifter. We cannot even imagine there to be a sound than which nothing could be louder, a white than which nothing could be whiter, or a

liquid than which nothing could be more mobile and flowing; there is some innate inconsequence in the very idea of such a thing, just as there is, for example, in trying to conceive of a time before which there was no time. The reason of this is that the criterion we take to determine any of those qualities is not absolute, or objectively appointed, but conventional; and hence it may in reason always be shifted indefinitely in either direction, thus making a given point to belong, now to one pole of the contrast, now to the other. Let us take rest and motion to illustrate this. If we define place very minutely, and take long units of time, it is evident that nothing will be so still but it may not be regarded as in motion; and conversely, in taking very short times, and not defining place too closely, nothing will be so much in motion but it may not be regarded as at rest. Now this equivocacy lies in the form itself of correlation, for it is the very nature of anything coming under that form to be what it is by comparison; and as the standard of comparison is a matter of pure adoption, it follows that there can be no extreme so extreme but that it may not in another, and all as legitimate, a view appear moderate enough to allow of something more extreme or intense. Again things on an extreme scale may always be represented as normal; a representation which shows that there must invariably be further degrees beyond that extreme, however far it is taken. An infinitesimal line, for example, may be represented by the one given above, and that demonstrates how there may be a still more minute; extreme human happiness

may be represented as misery to a god, and so forth.

Such considerations as these, after all, do little more than emphasize that relativity which necessarily attaches to correlation. Indeed it might well be deemed superfluous to press a point already verbally admitted, were it not that in a slightly different view many instances seem to combat it. One of these occurs in regard to temperature, to the scale of which, as we know, physicists are accustomed to assign an absolute zero, implying by this, as it would appear, that there is an utmost bound, a cold than which nothing could be colder. Again, when we see something very black, it seems reasonable enough for us to affirm that at least there cannot be anything a great deal blacker, which implies that there must be a limit.

To deal with counter-instances of this nature in general, let it be said at once that when all the particulars are laid down, or in one word, when the criterion is specified, maxima and minima will be reached. To this eye—we may say—at such a distance from it, and such an angle to it, against such a background, such and such is the quickest or smallest possible. But then these maxima are maxima according and relative to something given, and as such exactly they are not absolute. There never can be any apriori reason for making one thing the criterion rather than another, for taking it higher or lower on a scale; hence in form the degrees are limitless, allowing relatives extremes, but not absolute. The zero referred to above, for example, if I mistake

not, is a minimum relative to changes of matter as presented to us; that is to say, it is a least possible in so far as matter, having by then become all liquid or solid, will not do any more, or mark any further point. But a condition of universal solidity does not appear to me to preclude lower temperatures, any more than the solidification of a single thing, as water, precludes them; though, it is true, I cannot conceive how they could be materially marked for us below the zero. Still, not being able to speak authoritatively on this particular subject, I shall be content to rest my case on the general considerations already advanced. If there may conceivably be an absolute coldest, why not as conceivably an absolute shortest, longest, quickest, roughest, and so on? That there should be such maxima does not lie in the form, in the idea, of correlation; but relative to some specification an extreme may be attained, and within those given conditions it will be absolute. This will also occur when for the conscious thing, or appearance itself, we substitute some objective equivalent. If darkness is to be determined according to the action of certain waves, or however it may be, it is clear that we can conceive of a maximum darkness, viz., an entire absence of light rays; even though perhaps to realize this extreme, all matter would have to be eliminated from the universe. But, directly, darkness is a certain appearance brought out by opposition; a simple contrast that allows indefinite multiplication. For it is not in itself, or absolutely, but only according to what it is contrasted with, that any given point or individual of the species attaches to one extreme

rather than the other; so that essentially there is never a positive stopping-point. I cannot, it is true, specify the criterion, or name the percipient, according to which what is pitch dark to us appears brilliant light, any more than I can produce the giant to whom the distance between the earth and the moon is short; yet just as I know that there is no line so long as not to admit a longer, so I know that there is no darkness so dark as not to admit a darker: the form of the thing, not any concrete instance, shows us that it is so. Whatever criterion is taken to judge or define a darkness, it is never such that no other can conceivably replace it; and hence there is no ground for fixing an absolute limit.

These questions of degree, it must be understood, do not touch the true essence of correlation, which lies entirely in the contrast. To tell this contrast, and to judge under which pole of it an impression comes, it is clear we must have in mind some prior idea (in the Platonic sense), itself invariable and independent of what is presented to us; a pattern which can undergo no extension or alteration. Let us suppose, to carry this observation at once into the particular, that some god were to play us a trick, and make all dark things seem light, and vice versa; then that we took those dark things for light would imply that our idea, or pattern, had remained intact, or we should not have been able to pronounce them so. Again, if all that is now agreeable were to become loathesome, I say that our distinction of nice and nasty would not be altered in this; but that, on the contrary, we should retain it, and by it as a standard

determine the change; for objects do not dictate as to their quality, but the invariable mental standard does. For this model itself to change, there would need to be some second behind it by which to tell that it did change; but then this second would be the model premised, and not the first; just as to say that the standard yard is the fraction of a line out, you must make it not the standard measurement, and so contradict yourself, for every standard is as such immutable.

Let us now ask whether this "idea" of the correlation, which cannot be changed, can be extended. Would it, for example, really widen our idea of the hot and cold, would it supplement or modify it in any way, to feel something much hotter or colder than we had ever felt before? Essentially, no; for the essence of the idea is simply the contrast; and degree merely allows us to distinguish it more or less easily. Thus it does not make a thing hot that its temperature is fifty, sixty, or a hundred degrees; but that it gives an impression contrasted with that obtained from a lower temperature; nor does it increase the westerliness of a ship that it is a dozen miles west of a point, instead of only one. Could it be said, even, that we know less of the character of happiness and misery because, as Locke remarks, we do not know their utmost bounds? I think not. Not any more indeed than it could be said that a man knew less about longness because he had never seen the stars; for if he could see far past them, or contemplate ever so wide an expanse, it would add not a jot to his idea of long and short. This is why things of extreme degree have little more effect on us than

normal; for they must be conceived through an idea which is untouched by degree. To conceive of a star a hundred light-year's distant from the sun is really no different from thinking of a couple of peas a few inches apart; the character, the essence, the idea of the thing is just the same. And thus it is that immense distances, infinitesimal magnitudes, long ages, and the like, count for so little above the ordinary, and can in their practical significance be so hardly brought home to the mind. We see this also in the notions that the vulgar form of their divinities: superlatives are heaped upon superlatives, and yet the god remains a man.

The fact that the extra degree does not call for or produce any extension of the idea, may be pictured by imagining that there are in our minds certain set compartments, in which we provisionally place the greater and lesser impressions of a kind. Say that in the kind of black and white, snow-white occupies the top compartment; then upon the appearance of a whiter than snow, it will be degraded to a lower; for it is not as if any new and additional compartment were made for the rival. In effect, if we were to see something whiter against snow, the latter would appear to darken, and the whiter to take its representative degree, a latent darkness as it were being brought out by the fresh contrast. In the same way, whether we are given a distance of a million or a hundred million miles, all we can do is to put it in our superlative degree compartment, which serves in turn for the most various examples in the kind, as at an inn the best bedroom is made to do for bagman,

justice, or lord, according to the company that arrives ; and if the king himself came, he could be treated no better.

The gradation from one extreme to the other in correlation being continuous, nay, these extremes themselves not being positively placed, it follows that the exact line of demarcation between the two will be indistinguishable. Hence correlatives merge imperceptibly into one another, and precisely at what point one quality begins to preponderate over the other in the commixture it will be impossible to say. However, by taking parts of the whole sufficiently far apart, the difference will of course be perceptible. Again, by arbitrarily fixing upon some dividing line, equivocacy will in so far be avoided, any example having necessarily to come under one division or the other. However, to set up a line like this is necessarily to do a certain violence to nature, which gives no positive authority for it. If, for instance, I choose to define rest as the remaining of a thing in one place for at least one second, it is evident that by this definition it will be possible to determine between motion and rest—at least passably, for place itself may be determined either more or less closely; but it is also evident that there is no more reason, philosophically, for taking one second as the criterion than any number of seconds or fractions of a second. Hence, essentially, there is no definite dividing line between the poles of correlation. Good runs into bad, pleasure into pain, sanity into madness, tragedy into comedy ; and where one begins and the other ends we cannot exactly discern. Impression and idea is

another instance. We are frequently in doubt as to whether we heard a sound, or only imagined we heard it. Momentarily we may doubt whether we are asleep or awake. Success is near failure; and what we once thought ugly an artist will show us to be beautiful. When day becomes night, or summer winter, who can say? It is like looking at the hands of a clock: within a small space you cannot actually follow their change of place, but after an interval you perceive well enough that they have moved. Horace gives an illustration of the difficulty when he satirizes those who think more of ancient literature than modern. At what time, he asks in effect, does a book become ancient? Is the period a hundred years, for instance? But a year more or less can make no difference; so ninety-nine will do as well. But if ninety-nine, why not ninety-eight? And so on by degrees, showing that between ancient and modern there is no precise boundary. In driving the matter into the particular in this way, we become sensible that there is no more reason for fixing upon one criterion than another, and this leaves the point of separation indefinite.

As a result of this state of things that for a certain distance the two extremes blend in such equal proportion that neither specially seems in a preponderance, we have media. These media, it is easy to see, cannot be of the same rank as the two extremes or original natures; for they are essentially of mongrel breed, are half-castes. Their existence is a merely provisional one.

In departing from this middle region, the situation is such that there is produced at once an excess and

a defect, and every remove is a step towards an extreme. Now, applying a rule discussed above, it appears that nothing in nature can be entirely good or entirely bad, any more than a line can be exclusively long or exclusively short; for the point of comparison can always be shifted, and according as it is so moved the thing in question will approach to one end or the other of the complete category. Thus in the matter of worth, where they are such as to admit of valuation, correlatives will abstractly be equal, neither having an absolute priority. From one point of view, one of the pair will be good or suitable, and its opposite the reverse; from another bad, and its opposite good. The result of this is that all appreciable contraries are open on the one hand to correlative approval, as on the other to correlative objection. These objections of course become more and more acute as we approach the extremes, and they diminish as we approach a middle point, where the opposite qualities balance: here, then, neither side preponderating, the counter-objections which may be brought against either independently are disposed of.

It is in accordance with this circumstance that Aristotle has developed his theory of ethics, making the line of virtue or right conduct a mean between two opposing extremes. With regard to the species, fear, for instance, the correlative objections to be lodged against its extremities are that, as on the one hand absence of all fear is folly and leads to inglorious destruction; so on the other does its invariable presence impede action and enterprise, and leave the subject a prey to all sorts of abuse.

Nor are these objections dissipated but in a mean where, neither side having the preference, they neutralize one another; where, in our instance, caution tempering rashness, we venture as much as we guard, and guard as much as we venture. It has, however, been shown that correlative virtues attach to the two opposing elements, no less than that correlative defects do. If we have regard to these former instead of the latter, Aristotle's position will be reversed. In effect, his mean suffers from its equivocal and indecisive nature; it is neither here nor there, is merely provisional and negative in character. Considering, then, not the correlative objections, but the correlative good points attaching to the extremes, we should find, for instance, that fear was good in preventing us from incurring dangers productive of evil; was good, in short, as the main principle of self-preservation. Conversely, too, absence of fear we should find good in that it led us to despise a vain show of danger, to advance determinedly in our enterprises, and so on. These correlative recommendations, now, diminish as we recede from the respective extremes, and reach the vanishing point in a mean where, balancing, they wholly annul one another, just as before the objections did. In that mean, consequently, there will be no good; for in this opposite aspect the good resides in the extremes as such, which extremes and the good going with them are reduced to nothing in a mean. Here, therefore, it will be a matter of the golden extremes, the mean being no longer of that metal, but dross.

This will be recognized when it is considered that

the mean is a point of indifference where neither of the two elements definitely prevails ; in other words, a point to all extents and purposes where they vanish Hence if we view the extremes for what is correlatively objectionable in them, the mean, as annihilating them, will be the one point in the scale open to no objection, that is, it will be the point of preference ; but if, on the contrary, we view the extremes for their correlative excellencies, then that medium which predicates neither, will be bereft of any excellence, and will form the one point on the scale for unqualified rejection, inasmuch as, partaking of neither one good quality nor the other, there will be nothing to be said in its favour.

These two methods of analysis are at the very least equally valid, and if there is any preference, it is on the side of the latter, as this employs a positive as against a negative method. Aristotle examines lines of conduct in reference to what may be objected against them, and his aim is to find a point in any scale of action against which no such objection can be lodged, either on one side or the other. His line of right, consequently, his propriety of action, is something rather unblameworthy than praiseworthy. He reaches a point of conduct which is unobjectionable, unexceptionable ; not one which is positively virtuous. His goodness is neutrality—a purely minus quantity really, as not open to this reproach nor to that ; something harmless indeed but not beneficial. In ethics, however, the purpose should be to determine what is, not merely not bad, but positively good ; and therefore in utilizing the form of correlation, it would be

preferable to deal with extremes in reference to what was respectively good in them ; for these extremes are plus quantities, are the elements of the kind they together form, while media are not. In this way it would be shown perhaps that right conduct consisted in allegiance now to one extreme, now to the other, according to circumstances. For that is not the desideratum, to be invariably something between severe and lenient ; but to be severe in place and lenient in place, the propriety being nothing but the fitness of the act to the case.

What is here said in reference to ethics may be carried over wholesale to the realm of theory—I mean, to the theories and opinions about things. For every subject seems to have two sides, and to admit of being viewed from diametrically opposite standpoints ; all theories to fluctuate between two extremes, as nominalism and realism, materialism and idealism, scepticism and dogmatism, rationalism and spiritualism, optimism and pessimism. These extremes, as before, involve correlative pros and cons ; correlative objections may be brought against either extreme, and correlative arguments advanced in their favour. If against conservatism it may be said that it is a bar to progress, and perpetuates the outworn; then against liberalism one may lodge the correlative objection, that it advances too far and tends to destroy a necessary stability of institution. On this account opinion is observed to oscillate, and in passing from side to side is compared to the swing of a pendulum. As it approaches to one extreme, it becomes more and more sensible of the objections attaching to this side,

till at last it takes a backward turn, and passes over to the opposite pole, where it undergoes a similar reversion; for our nature is such as to be more sensitive to evil than to good, or at least, to see disadvantage more in the present, and advantage more in prospect.

In view of the fact that corresponding objections always apply to the extremes in these cases, we might think it perfect folly ever to take sides in a dispute, knowing as we may in advance that both will in so far be wrong. We might, I say, well come to this conclusion, were it not that the alternative has even less to recommend it. To avoid extremes is to take up a position of indifference between them; and this, as indefinite and indecisive, as neither here nor there, is altogether unsatisfactory. This indefinite midway position is the one adopted by scepticism, into which people may easily be driven in considering the dual and equivocal constitution of things we have been describing. The one safeguard that I know of against being forced into such a predicament as this is to specify your criterion; for then, having a *point d'appui*, your force tells, and your arguments, even if narrowed in application, at least hold good to that extent. As regards this criterion we have seen that in pure reason there is no preference as to what shall constitute it, or where it shall be taken; for there cannot be such a thing as an "absolute" criterion. Hence we have the correlation of pros and cons referred to, and as a consequence of these, casuistry in morals and sophistry in ratiocination. However, in a practical sense, there is for us a certain

priority in the matter, a certain criterion by preference: ourselves, namely, and our capacities. Man is the measure of all things—the criterion everywhere tacitly appointed. This is our one quasi-fixed point, and in departing from it, a person is virtually, if not philosophically, in the wrong.

How widely correlation extends; what a large proportion of ground it covers in what we experience or think about, may be seen from the fact that special dictionaries are compiled to deal with the names of things and their opposites. Evidently, to recognize the principles or laws governing the whole of this so varied class will be no small gain.

## Materialism

MATTER is anything that takes space. To represent it we cannot do better than think of some common thing, like a block of stone, a clod of earth, or a lump of clay. I say "to represent it," because as an abstract term matter is itself immaterial, and cannot be pointed out as an object in nature, any more than among men we can point out man. I might perhaps have added that matter is what ostensibly, or palpably, takes space; for it is the very essence of a material object to be sensible to us. Whatever we do not feel or see to take space is in so far not material, as the air ordinarily is not anything material; but when enclosed all gases and liquids are felt to be solid enough and to take up a certain room, and so they too are held to be material.

This description of matter will sound simple, and many think that what is simple must be inadequate; but a fundamental notion like this of matter is not complex; and having exhibited its character in some representative way, we have gone as far as we can ever go in defining it. Some people think that by close experiment and analysis they will be able to get a new and more intimate idea of matter; but no investigation can alter those our faculties which

determine in advance the essential form of the conception. It will not serve us any better, for instance, to imagine very little bodies, as atoms, or very big, as whole worlds ; nor again does arrangement alter the case, for in any body it is the particles of it that make the matter, so that whether these are uniformly pressed together or are permeably arranged in the form of a sponge has no bearing on the question, and does not assist us to any clearer view of matter. A person who, in looking at a lump of clay, imagines it as composed of an infinitude of atoms is simply multiplying his original conception ; for in effect he figures those atoms in no other way than he does the lump itself seen as a whole.

Some scientists even, refining upon the subject till nothing is left, have pronounced matter to be a form of motion. But motion postulates matter ; to move being what matter does, not what it is. We do indeed hear mention of such ghostly entities as "ether vortices" and "disembodied electrical charges" in connection with this theory of matter ; but such subtleties as these either cannot be brought before the mind at all, having no shape and no appearance, as electrical charges ; or else they already involve the very notion they are brought forward to throw light on, as a vortex wants matter to which the whirling may occur, and so instead of introducing us to the idea, requires us to bring it with us.

Using the term "matter," then, in the elementary sense first given, a materialist may be said to be one who accepts matter as his ultimatum, views all in the light of it, and seeks to account for things through it.

He sees that nothing can be definitely depicted to the mind except as matter, and so reduces experience to that basis. He keeps to the sensible object, to what is ostensible, and what may be handled and measured and timed and weighed.

To matter in general, which as such is without quality and altogether bare, only one thing can occur, and that is to be moved or brought to rest. Hence the utmost a material explanation can do is to refer us to matter in motion, to bits of stuff in space either still or moving about. It is useless to turn and twist about with imposing phrases, and to try to make out something very special; if we are to come to the point and materalize the subject, it will be as I say. There is nothing else to happen to matter but being moved or placed; and therefore in a purely material account of anything, we can only be shown bodies either in some stable arrangement or in motion. In this vein whatever is carried to its first elements will be resolved into some sort of motion: heat, for instance, is figured as a kind of motion; light and sound also; thought, feeling, and even life itself, no less; and so on. For this is all that can be done with mere matter—to have it moved about, or act by pressure or shock. The purely material explanation is consequently bound to be at bottom a barren affair, for it is restricted entirely to the mechanical side of things; at the same time, as far as it does go, it is perfectly logical, and clear to the point of transparency.

When we are familiar with the working of a machine we understand how motion is translated

from one part of it to another, how one wheel turns another, and in general what action follows from what. Yet as a machine precisely the whole thing is dead, so that our information is in a way no information; for the mechanism of a machine does everything but make it go, includes all but the force, the vital principle. This indeed is nothing ostensible, and hence has to be left out of account in a material reckoning; yet without it, none of those actions that the mechanical explanation seems to afford us an insight of, would be actions. The steam, the expansion of which makes an engine go, can be shown easily enough, but not that which makes the steam expand; for this is not physical at all, but metaphysical. This is where materialism is so deficient; for, as something immaterial and not coming within the scope of its cognizance, it cannot even acknowledge that there is any such occult principle, as it were, infusing all phenomena; and so, notwithstanding its detailed and logical presentment, it really only skirts its subject. To illustrate this failing let me take an instance from experimental physiology. This science explains how it is we see by saying that the visual centre in the brain records in corresponding cell modifications the visual character of the object looked at; and it points in proof to actual tangible things, as nerves and brain tissues, having perceived the material effects, and having shown that if the respective cortical centre is destroyed, the changes induced there no longer result in conscious sensation. This account, now, takes us from the eye to the brain, yet leaves us as much

outside as before; it refers us to cell modifications, but what or where is that which notices, which marks and minds, the cell modifications? for this is the very essence of sensation, surely, that it comes to one's notice, and in a word is sensible to one. Materialism not only cannot answer, but cannot even allow, such a question; it must not recognize the existence of what we call mind, or so much as suspect that there is a principle of this nature wanting to galvanize its dry bones. The soul is not on its official list, not in its world even, there being nothing ostensible, no object, no matter of that description. Neither, it is true, can an idealist produce or reveal in an objective form the spirit, the animating and efficient element of things; but he does allow for it, and indeed sees that it is the highest reality, the quintessence of all. Materialism, as I say, has entirely to ignore this element, and assumes that in kind at least its own explanation is exhaustive. It seems to be under the impression that if we had, say, fifty senses instead of five, and those of an exquisite capacity, further motions now eluding search or imagination would be disclosed, and nature's inmost secret finally grasped. But all this would only be a multiplication of the material world, like setting up a dozen mirrors in place of one; for it is not that the senses are restricted, but that the method of going exclusively by them is.

It results from this inherent limitation that however complete a material exposition may be, it is always lacking; it leaves out the life of the thing, and so its world is a world of automata, dead, impassive,

uninformed. The deficiency I mean may be conceived by supposing ourselves to visit a planet where everything did go by machinery. Really the more we understood of the mechanism here, the more incomprehensible the whole would be. To see everything acting and working in dark senselessness, without purpose or end; to see it going blindly on and on, void of understanding, inner light, true animation—I say we might know the entire gearing of the system, and yet be confounded to behold and consider it. Our own world sometimes appears to us in this light, and that is when we are viewing it materially. Or take, again, a single thing instead of many, and imagine a mechanical man. We might say about this automaton that the more it resembled its living model, the more it would differ from it; for the closer it aped human nature, the more strikingly it would be forced upon us that what it did lacked the essence and the elements of the original. The performance of an automaton, however perfect, is a parody for this reason: not because it is less delicately or accurately carried out, but because there is no thought behind the act, which thus becomes a superficial, hollow mockery. In this connection we can think what it would be like (if it is not going too far to make this further considerable call upon the reader's imagination) to meet a god-made automaton, acting outwardly much like other men, only exhibiting in some way that it went by machinery; and can conceive how much more inscrutable a thing it would be to us than ourselves, even though we had the drawings of all its parts by us.

Instances like these will serve to show how much is still missing in the merely material presentation of facts; and how, in fully grasping them, we may be as far off the point of a case as before. Indeed it is evident enough that, in strict speaking, nothing does go by machinery; for, on the contrary, machinery is what requires to be made to go. This is done by means of force, which as a wholly immaterial and enigmatic element ought in consistence to be disregarded by materialism. The materialist, however, cannot but posit it, as for instance in those physiological studies referred to above we find mention of a certain *vis nervosa*; but he does so under his breath, and without dwelling on the subject. All natural sciences, as Schopenhauer shows, refer back in this way to some general force, which they peremptorily take as a first principle, and do not further explain. But from the truly material point of view force must be regarded as a fiction, since there is no matter answering to it; and therefore, as a foreign element, it never really enters into or forms an integral part of any material analysis. This circumstance gives to materialism one of the principal of its characteristics—its deadness.

From deadness in being we pass by direct connection to necessity in action, which is a second leading trait of materialism. Determinism and materialism have ever been found going hand in hand; indeed they are blood relations, and proceed from one and the same attitude of mind. In a machine, one wheel moves because it is interlocked with another; this because it is connected with a third, and so on, one

thing following from another in strict sequence and with obvious necessity; for bare matter cannot take the initiative, but must be made to act by force. Hence cause and effect become the natural stepping stones of materialism: in its view everything must be covered by that principle, and all events, as at bottom mechanical, rigorously determined. And indeed it is right that every ostensible thing should as far as possible be brought into such a connection, and should be regarded as falling within the compass of the law; it is right, I say, that the world should obtain the fullest mechanical explanation; but then it ought also to have a moral, or vital, one. I think, in fact, that there would be no fault to be found with materialism if it did not want to pass for all in all. No doubt, as far as the separate parts are concerned, it does very well to make one depend on another; but it affords no support for the whole. That the motion of one cogwheel determines in strict measure the motion of another, we can understand; but that the whole world goes forward driven by blind necessity—it is incredible, inconceivable. Yet this is what materialism is forced to imply; an idea so crude that the veriest savage revolts from it. Only think of some great machine, sunk in the abyss of space, pounding on and on, mysteriously impelled by the mysterious, no one within it, no one without. What would it all be for, what about? what sense, what good, would there be in it? by reason of what should it exist? It is thus, as we noticed above, that while within narrower limits materialism renders things so clear and com-

prehensible, as regards the whole it simply throws them into greater dubiety than ever. This is because it does not admit of will, which is the master-key to the system.

Will can be conveniently looked upon as the subjective correlate of force; for what force is in mechanical action, that is will in sensible action. But materialism, as we know, consistently regards everything as mechanical, this being all that it has eyes for; and it puts its special construction even upon voluntary actions (which else we are not accustomed to see in this light) declaring them to be necessitated, forced; and rightly, too, in so far as they are mechanical. But there is not only one way of apprehending these actions; there is not only an outside of them, if I may so express it, but an inside as well. This side is the conscious, the subjective side, when we ourselves directly enter into the affair, and are the subjects of it. Here, when we are no longer merely viewing things from the outside, but are immediately experiencing them, force is replaced by will, that is, by choice. This will be readily understood when we reflect that force can only be brought to bear, can only be active where there is resistance, inertia; but we fly to what accords with our bent and nature, and so any force here could only be performing supererogatory services. This is why it is so incongruous to predicate compulsion of anything done with a will, for there is nothing in these cases to oppose and so give effect and being to the suggested force. The contradiction is radical, too; a positive misapplication of ideas

underlies it; since, as I point out, force is an idea that rules in mechanics, but not in morals, where we find will as the corresponding element. True, at bottom, these two are but different poles of the same thing, but as such exactly they are mutually destructive, and cannot commingle: where will enters force must be absent, and conversely, as the moon wanes at the rise of the sun, or shines forth as it sets. If we first kill our man and approach him, or rather it, as an object in the purely ostensible world, we can then properly apply the notion of force; but not otherwise, for the man vital is a creature of an altogether different sphere, the subjective, where what in the objective presentment was conceived of as force takes on the character of will.

Force we only know of distantly, but will is so intimately present to us that in a way it is what we are. Nothing is more comprehensible to a man than that he should have likings; nothing is more reasonable—nay, it is reason itself, in that we give our will as a reason for what we do, but not a reason for the will. In view of this priority it is no wonder that we should understand things much more vividly and exhaustively when explained through will; and no wonder that materialism, not being able to draw on the latter, but only on force, should be so bare, inelastic and inconclusive, except for certain restricted purposes. Order may rule there, and frigid perfection prevail, but the world according to materialism cannot ultimately be other than a piece of mechanism senselessly impelled by blind force. This is a picture at variance with experience; an answer that provokes,

instead of allaying, perplexity. To conceive of the world in this fashion, then, simply saying that there is fate and force behind it, is to make it something that we cannot grasp, something unintelligible, irreconcilable; whereas that it should be here and be going on by will is as plausible as can be; indeed, I may say it is patent. The nearer reason of this is that materialism, abstracting from will, has no place in it for final causes, but only for formal. Consequently, it has no means whatever of dealing with the world as a scheme of things, as a significant project, and is unable to view the subject in this light. But in positing will this all-important approach is rendered fully available, and gives access to what is found to be a true resting-place for the mind. It makes no great difference whether we conceive of the necessary will as belonging to some particular being, or figure it more generally, the mere fact of exhibiting what confronts us as being the pleasure and answering the purposes of some nature at once puts it in an intelligible light; it gives us something more than the bare cause, it gives us the *raison d'être.* But if the world is presented as something entirely involuntary, as an eventuation that came about and a process that goes on without anybody's wanting, why, then, it is an enigma, nay, a positive contradiction; so much more manifest and comprehensible is the whole to us as an object of will than an object of force.

Yet after all the two aspects, the moral and the mechanical, the subjective and the objective, must balance and supplement one another without pre-

judice; for it is in their combination alone that they display the true perspective, just as it needs the fusion of two different images to give depth and body to what we see through the eyes. Or we might compare them to a pair of complementary colours, which together produce white or black, but separated stand in marked contrast. In the instance before us the contrast is certainly pronounced enough. Looked at from the material point of view, things will be clear cut, positive, and rationally connected, and we shall be able to grasp them in a more definite fashion; but they will be dead, spiritless, inert; their action will be mechanical, that is to say, automatic; they will go forward under frowning laws by force, by necessity, by fate. Seen, or rather entered into, from the subjective side, on the other hand, things are made quick with feeling, intelligence lights the way, and the course of affairs both singly and in sum becomes voluntary, chosen. Here, there being will, there is purpose and inner significance in all; there is some good in what is going on; there is something to be touched, something to mind. Materialism's outlook is cold, impassive, impersonal, but withal strict and accurate; it disassociates itself and holds itself aloof from its subject matter, which it reduces to a mere form or appearance: in this light, the world as a whole, or any one of its separate operations ultimately, must present itself as a vain and empty performance. On the contrary, when we admit more than matter into our philosophy, things will no longer be treated thus distantly, but will call forth some feeling; for we shall then realize our

case morally instead of formally. Further, that materialism is matter-of-fact goes without saying; it is under no delusions, as it says, and finds everything plain and straightforward: but idealism inclines to the mystic, suspecting more in things than they show, and reckoning always upon some indefinable element—it dwells in haunted places.

This last, however, is a remark that requires some special qualification, for many people are extremely matter-of-fact in their mysticism; ideas are not enough for them, and whether it is a human soul or a pound of beef, they call for the matter of it just the same. Only consider what goes by the name of spiritualism, for example, and see the undisguisedly material turn it gives to subjects of a transcendental nature. By all means let the human personality survive after death, if you will; but if it is to bob up again from the grave in the old way, now appearing to a friend, now sending a written message, now impressing its image on a photographic plate, and so forth, why, this is a survival lock, stock and barrel; it is the material thing causing material effects as before. Again, that spiritualists should propose at all to place their theories on an experimental basis, and to produce "evidence of the action of discarnate human beings;" that they should attempt such a thing, for instance, as to weigh the soul, only shows how permeated their minds are with material ideas. Experiment, evidence, action, all concern what is concrete and physical, not what is truly psychical. Spiritualists further betray their rank materialism in their argumentative appeal to our "limited faculties,"

suggesting to sceptics that, with additional senses, things undreamt of in their philosophy would be revealed to them. And so they would, to be sure; only they would still be material things; for it is not the absence of a sense of them, but the radically distinct way they are grasped or conceived that makes idealities what they are. Twenty senses could do no more than yield some object of sense, some ostensible thing, but an ideality, a metaphysical entity, is not even potentially of that description; it is an object of an altogether different order, namely, of pure understanding. The fact, then, that spiritualists adopt this line of argument is a proof that they have no true appreciation of their subject: that the very essence of which is not to appear at all, they are not satisfied until they have made phenomenal. Their furthest ideas are in terms, if not of downright materialism, then of potential materialism, and their psychical is merely the physical once removed.

Materially considered, life is simply motion, for that is the only ostensible difference between the bodily organization a moment before and a moment after death; the same parts are there, the same structures, motion only has ceased. Morally, however, we recognize something more, seeing that this inert frame was but a moment before nervous, impressionable, informed, capable; and we say that the soul of the person has gone, meaning not any phenomenal thing, not anything heard, seen or felt, or even to be made sensible by any extra sense, but implying something understood or indirectly

conceived—the metaphysical principle that inspired the material system. I think that no one can see, for instance, an ox felled, or with a start pick up a living for a dead thing, without strongly realizing the actuality, or rather verity, of some such animating principle. But to wish to give this transcendental quantity, this soul, still another shape and form, as that of a heart with wings, or what not, is inconsistent; for in so far as it may be represented at all, it is the body which stands as its material equivalent, or manifestation, and otherwise it is wholly ideal. This necessarily renders the subject obscure, and indeed removes it almost from practical treatment, especially when the questions raised are cast in material form. The points at issue are rather to be illustrated by indirect means than settled in any positive way, for it is really only about materialities that we can be explicit. Thus, if asked where the soul goes at death, we might very properly reply, "Where time goes when a clock falls to pieces." Place and presence do indeed apply to things, but not to an ideality, which as such neither comes nor departs, neither arises nor decays. It is, by the way, a very striking confirmation of the metaphysical nature of the change that occurs at death, that there should be no immediate and infallibly certain test of it.

Of idealism turned to matter of fact there are grosser examples in popular religion than anywhere. Heaven must be so many cubits long and broad, the body is to rise again, corporeal punishment is to be inflicted, and so on; for the human mind abides in the concrete

and material as in its element. These notions are fanciful, not idealistic: they do not keep to the idea, as idealism would, for instance, in saying that the essence of our being is no more touched by death than the shape, cube, is annihilated when a lump of sugar is melted. Though a more matter-of-fact interpretation may do provisionally, it eventually works great mischief in effectively preventing us from having any real and lively feeling for the dubiety of things, for the hidden factors in existence.

In ethics, finally, materialism passes naturally over to the utilitarian camp, making virtue prudence; in art it leans to the Philistine; and in common life produces the practical man and the man of the world.

## A Question of Time

PHILOSOPHERS are agreed that time is not an object of conception, but a form of conception. Hume gives a simple instance of this when he says that five notes played on the flute produce an idea of time, yet that that idea does not arise from any sixth impression, but merely marks the order in which the five are apprehended. His view and the reflection that no amount of turning over ever discloses any presence in nature answering to the description emphasizes the ideality of time. A person has only to try to frame a bare notion of time in his mind, and he will be baffled in the most mysterious way: it is as if he were trying to seize hold of a phantom; like the Ghost in Hamlet, 'tis here, 'tis here, and 'tis gone! Nothing material will represent it, nothing ocular manifest it; and the closer we peer, the more shadowy it becomes.

The reality of time, on the other hand, comes home to us when we consider it practically as a condition of action. Between sunrise and sunset, for example, we know that only a certain amount of work can be done, only a certain distance be traversed on foot or awheel, only so much of a field ploughed, and so on. We conclude, therefore, that that which thus limits the possibilities must be a reality. Still, on reflection,

time does not seem to be positively concerned here; for it is in itself powerless, and does not put any hindrance in the way of a man, that he cannot walk or do sums quicker than at a certain maximum rate. This hindrance lies much rather in the constitution of the creatures and things concerned. Time is not an agent, and therefore nothing can directly occur or be prevented by it: in it indeed things occur, as if it were some medium or element, but not by it. Elliptical ways of speaking allow us of course to say that time cures all, turns a man's hair grey, and so on; but such expressions can only mean that adequate causes acting during the passage of time bring about these effects.

But what is it, then, that passes in the passage of time and what endures in its duration? Surely we refer to something in these expressions? We refer, as it seems to me when I consult my thoughts on this point; we refer to different states of things contrasted against a single state. Since early this morning, for instance, the state or nature marked in this locality by darkness has passed away, and a different state has taken its place. This is a broad distinction; but just as the deletion of a single letter will in so far alter a whole book, so the most trifling circumstance will serve to identify or diversify the universal state of things. We need not have the whole in view; it is sufficient to observe that an infinitesimal portion of it has altered, to know that the whole has done so. The movement of my little finger, the trembling of a single leaf, is enough to introduce a new state of things, to

cancel it, to replace it, and so on, in the quickest succession. These various states, all distinctly individualized by some special circumstance, are that which passes; while that which endures is some state or nature in general.

Through the endless succession of changes upon changes that have occurred, say, since our world formed from the nebula, there runs a certain identity within which they are all included; an identity of which it could be said that with any and every separate state or existence it too was. This identity that prevailed throughout the different happenings and alterations is the existence of the solar system altogether; for in a very general regard the mere being of these things is one and the same state. Time consists in the juxtaposition of these changes and this identical state; springs out of this contrast, and subsists in it.

If we interrogate ourselves, then, and inquire at the lapse of a minute or an hour what it is that has gone, we shall find that this can be nothing but a certain one state of things, identified by some circumstance altogether peculiar to itself. Of course, did we merely differentiate among states of things according to species, there would often be great difficulty in distinguishing them. But in the same way that we easily know one grain of sand not to be another, namely, not by any specific mark in either of the objects themselves, but from the simple fact that some third nature separates them; so are parts of time individualized more according to general considerations of position and separation than by specific marks.

Anything individualized, however, is as such absolutely unique; and so, once destroyed, can never appear again. Any state of things, therefore, once marked and superseded, can never recur. There are depths in this thought, if one can only fix upon it properly; in the thought, I mean, that it will *never* be the same again as at this instant, and that even while we are thinking, we are losing something irretrievably and forever. What is to come is uncertain; so that if the present is at all to our liking, here is a reflection which, while warning us to appreciate the hour, will embitter it with regret.

The way time is to be pictured depends on whether the contrast is made from the side of the one great identical state of things, or whether from that of the many. If we take the former as positive, namely the single state of things that embraces all that is and ever has been going on, then the appearance is that while things pass, time stands still. If, on the opposite hand, we take for positive the particular changes splitting up this identity into parts, then time, as strung together out of such parts, appears to pass, the individual situations slipping one by one away. Again, whether we are carried past a stationary scene, or, ourselves stationary, moving scenery is carried past us, the impression is essentially the same. It is equally consistent, therefore, to imagine either that the points of time flow past us, coming into and receding from our ken, or else that we ourselves are hurrying on and on along a line itself stationary.

By means of memory, which in its gallery preserves

a replica of salient events just as they occurred, we prepare ourselves a kind of diagram of nature. In this diagram time in its reality is eliminated; for the whole exhibit is stationary, and events, instead of proceeding from and into one another, remain as they were; moreover they are all present at once, their sequence in time being only formally indicated by set arrangement. Thus we come to regard the past as if it were still as it was, though not so for our senses. We keep it fixed and in being, as if in some transcendental view it could be perceived in company with the present, as a balloonist might see a long stretch of railway which to those passing in a train is only partially visible, a piece at a time. Again, by parity of conception, many view the future as if it, too, were already as it is going to be, only that we had not yet come up to it. This is consistent; for it completes the diagram, and throws the whole of nature into the same statical form. It is a view that has led to the idea of fate. If what is going to be already is, there can of course be no altering it: we have only to wait till we reach that situation. Or conversely, if what is going to be is determined, it must already be in some shape or form, say to some transcending eye or spirit.

In nature, as we directly apprehend it, there is nothing of this sort. It presents itself, on the contrary, as a constant metamorphosis in which the past, instead of being retained as a separate existence by the side of what succeeds it, wholly dissolves into the present. Nor is the future here ever added on to a present, leaving that as it is; but it transpires out of

this present in the way of transformation. Thus in nature everything is in the present; the past is not left stranded, but is pressed into and embodied in whatever now is; it is carried along, not passed by. In our diagrammatic rendering, on the other hand, the past is definitely cut off from the present, and is kept in *statu quo* interminably, as if it really were there by the side of the present, only situated beyond the immediate horizon of the senses. This is a mental arrangement analogous to that of a "panorama," where a foreground filled with real objects is joined to a merely painted scene behind; for in the mind, memories having no existing material counterpart are joined by an illusion of perspective to present substantial impressions, and produce a panorama, or statical representation of experience.

For any difference of time to be actually marked to the mind it is evident that there is needed some perceptible change in the state of things,; for no perfectly uniform experience could ever manifest the succession involved in the passage of time. It is equally evident, however, that this necessary change need not be an external one. The fact that the objects I am looking at remain completely unaltered does not prevent me from being conscious that time is passing all the while; nay, that I know they remain itself involves a sense of time. Take another example. A person shuts his eyes and listens with his whole attention to the blast of a horn. The quality of this sound, as we will assume, is even and identical throughout, so that there can be no indication in the impression itself adequate to

distinguish the beginning of the blast from the middle and the end. Yet the listener does distinguish such parts, and knows whether the whole is long or short. The explanation is that, while the sound is one in kind, the listener's perception of it is not one, but many: he perceives it, and re-perceives it; is aware of it over and over again. These various perceptions differing in their immediacy, or presence, each mark an altered state of things, and give a sense of time.

In view of such facts as these it is generally said that we are conscious of time by the succession of our thoughts. This, however, is not quite correct; because, unless attention is directed specifically to the coming and going of thought, unless we deliberately watch ourselves thinking, and repeatedly assure ourselves that we are conscious of a thing now, now, and now again, the time difference is not noticeable. Where we are imbrued in the thoughts themselves, as in a reverie, though they may succeed each other ever so fast, and take us from one end of the world to the other, they then give us no indication of time, but rather make us forget all about it. If while a man is noting the several impressions he is having of some unchanging object, his attention relaxes, and he either thinks of other things, or else, suddenly attracted by a peculiarity or beauty in the object, dwells in contemplation, he will let an interval of time slip by without noticing it. For that interval he was lost in thought, released from the treadmill of time. Not any succession of thoughts, then, will make us conscious of time, but only such as are

diversified in the very way we apprehend them. If a train of ideas is continuous, and the various parts of it all relate to one thing, the mind in following it is focussed and kept in one, so that notwithstanding the succession, our experience is here unified and pressed into a single point of time. In other words, the distinct consciousness of time involves a kind of double attention: it is not sufficient that ideas should follow one another, but they must be perceived to do so.

At first sight it looks as if the idea of time were introduced by the natural sequence of the things that we become sensible of. However, that this is not the case will readily appear when we consider, for example, that a moving-picture film reeled off the reverse way fails to produce in us the slightest sensation of time going backwards. It simply seems as if some magic were at work, counteracting the ordinary run of nature; but time does not seem to be going differently, to be running backwards or undoing itself. This shows that the idea of time is not dictated by the order in which things happen. We can perhaps only faintly imagine what it would be like if the whole course of things were to be turned back upon itself, if men were to begin by some hidden necessity to grow younger, and unlive their lives; but we can imagine enough to see that even so complete a conspiracy as this would have no effect on our conception of the unimpedible flight of time. Provided that we had not been driven mad in the meantime, every event that we came back to would present itself as a repetition of a *former*

experience, and so its recurrence by the mere form of our apprehension would necessitate and mark fresh time. Hence it may be said that though nature itself ran backwards, time would still go on.

As a corollary to this curious reflection, it may be observed that the rate as well as the direction of time's flight is known to us much rather by some innate criterion than by any direct imposition by the senses. Hume says, "According as a man's perceptions succeed each other with greater or less rapidity, the same duration appears longer or shorter to his imagination." This is a mistake. When a pianist plays me an *allegro vivace*, my perceptions must succeed each other with much greater rapidity than when he plays a funeral march; yet time does not appear to go differently because of this; on the contrary, I am conscious whether the musician is playing faster or slower, or in other words, how he is filling stretches of time quite independently computed by me to be equal. I do not, then, judge the flight of time by the perceptions, but submit the perceptions to a measure of time already existent in my head. Let me give another instance or two illustrating this point. If we are listening to an engine, we easily notice when it is beating in time, and when it goes faster or slower; the majority of people, too, can themselves beat time as accurately almost as a metronome. Were a manager to order his actors to play their parts twice as slowly as usual, the whole audience would immediately be aware of it. But to say nothing of special cases like this, unless we had some natural, intuitive time-scale to rely upon, how

could we ever form any notion whether an action were quick or slow? The comparative distinctness with which we catch separate sights or sounds seems to afford us the chief criterion in these judgments. If we can distinguish every syllable uttered, the speaker is delivering himself slowly; if a ball can be seen distinctly in successive places, it is moving slowly; while if it can be noted two or three times over to be practically at the same spot, it must be going at a crawl; and so on. This, by the way, might be given as a reason why a man who has learnt a little of a foreign language always imagines that the natives speak it uncommonly quickly.

The contrast between mechanical time and conscious time produces the quickness or slowness with which we say time goes. The general principle is that what unifies experience makes time short, and what diversifies it long; the number of the thoughts passing in the mind has nothing to do with the estimate; it depends more on how they are broken up or united, and how they engage our attention. For time to seem to go slowly for us, it must consist sensibly of a great many little times. The more distinct little times we are aware of in any given standard time, the longer it seems. Routine, by unifying experience, makes time go quickly; while constant change, by diversifying, lengthens it. The first day in a new situation seems interminable; and on returning from a fortnight's tour abroad, it will seem almost a month since we set out. Of course, no mere sameness of things will guarantee unity of consciousness, for the mind may be wandering

restlessly from subject to subject, and by its own dispersiveness make time tedious and long. This happens, for instance, when a man lies awake at night: he is constantly reflecting that he has not yet gone to sleep, and each time he notes it, he considers that it is a different, a later, time. This breaks up the interval into innumerable little pieces, and gives him an exaggerated idea of its duration. It is the same in waiting for anyone: we cannot properly get interested in any one thing, but are continually reminding ourselves of our situation; and each distinct consciousness that we are waiting, are still waiting, and still again waiting, is a beat of the natural clock. Hence time drags. Interest, excitement, occupation, on the other hand, so precipitate us that though we have a thousand thoughts and feelings, the consciousness is but one; and when at length we come to ourselves again, we are surprised to find that so much time has passed. It is not that thoughts have not succeeded each other with great rapidity and in great variety in this occupied state of mind, for they obviously have, when we come to look into it; but they have a fundamental unity, and flowing in one stream, form a single uninterrupted experience.

Motion, whether it be of time or anything else, is so entirely relative in its nature that, where there is no second object to refer to, it is indefinable, which is to say, imperceptible. To perceive the passage of time, then, or what amounts to the same thing, our whereabouts in time and how we are advancing over its formal parts, it is necessary that we should take our bearings by the changing state of things about

us. It is just this contrast that is missing when a person is absorbed in any pursuit: one single subject claims his attention; but this offers no basis for the comparison, and so until the thread of thought is broken, he is insensible of time. To a sociable party thoroughly absorbed in an exciting game of cards everything beyond the limits of the card table in that one little room is temporarily blotted out; to them, for so long, all other affairs, all other happenings, are obliterated. At length, a round having been finished or a late hour striking, they suddenly come to themselves again, and reluctantly admitting an outer world to their thoughts, find that time has flown. During this trancelike absorption these people were pure subjects of experience, that is to say, mere vehicles, and as such they existed pretertemporaneously, or in a timeless state. Afterwards as objects of their own reflection they perceive in what relation they stand to other objects and some general state of things, a comparison that gives them their bearings in time. To be temporarily lost to the world in this way is a great happiness, and to attain the state is the aim of all amusements; nay, people throw themselves into the most arduous and hazardous undertakings with the same end in view. Dreary tedium is the alternative. Time, watched too close, is a dragon, and must be slain. The art of killing time, according to my definition, must consist in attempting to unify experience; but it ought to do this in exercising, rather than in drugging and deadening one's faculties. It might be added that just as a game or task or spectacle renders us

insensible to the passing minute and even hour, so, too, in a major degree does our absorption in the daily routine deprive us more or less of a perfect sense of the passing week and month: we know when they have gone, but we do not feel them going. To become aware of ourselves, finally, as passing through life-time; to see our age as successive to numerous others, and in short to have an approximate sense of what I might call world-time;—this is the very rarest occurrence, an awakening to a philosophical appreciation of things.

That one beat of a pendulum equals another and marks an equal lapse we are entitled to presume on the ground that the same natural operation must always take the same time. If there were any difference in the time, the operation would not be precisely the same one, but would have taken place under slightly different conditions. If only the conditions under which a clock works could be kept absolutely uniform, it would necessarily be a perfect time-keeper; for, speaking with a little latitude, we may say that the operation is the time and hence that uniformity in the former is uniformity in the latter. To insure such uniformity, pains are taken to make the parts and bearings of clocks as accurately as possible, to maintain an even temperature, or to compensate for a variable, and so on; but it is only the more immediate conditions we have control over. If a portion of the earth fell away, all clocks would go slower, and all free motion be proportionately retarded; if further, the earth's rotation time were to be correspondingly lengthened,

we might have time going slower without any difference being manifest. The clock would then take, say, 70 minutes of the present mean time to mark but 60 of the new. Whether any such wholesale alteration as this—the days, the seasons, and everything, all changing in due measure—would be intuitively perceived, is a question that I shall leave to the ingenuity of the reader, merely observing that the phenomenon of "periodicity" in our functions goes some way to form an inner and partially independent clock.

The prolongation of life is a concern that has always been a good deal in men's minds; and no doubt, reckoning length of life according to the clock and the calendar, some addition to its average span is more or less practicable. But having regard to what a person is directly sensible of, it seems very questionable to me whether any allowance of years whatever would make life realizably longer. I rather fancy that if we lived longer, we should in effect live just as long as we do now. If anyone thinks this paradoxical, let him consider for himself how he would propose to introduce more time to a person's consciousness. Time is not cumulative, and as several parts of it cannot be present to us at once, but must appear singly and in succession, we have no direct feeling of any length of it as a whole. When we recall some long wait, we go over the feelings we had at that time, remember barely how dull we found it, and what we did to kill the time; but to have a proper sense of the length, it would be necessary actually to pass another such

interval. Very similarly, that we have lived forty years, or are presumably going to live forty years, cannot in any living form be brought to mind. There is a limit both to anticipation and to memory—a mental horizon circumscribing the field of vision. In passing along the years we lose to view in one direction what we gain in another, so that only a given amount is ever present to us. A man may travel to the ends of the earth, but he does not get far; it is always "here." And he may live to the age of Methuselah, but it is always "now." This "now," which is the only form under which time is immediate and a reality to us, is however in its very nature inextensible; and so, whatever addition were made to a lifetime, as the extra span would necessarily be distributed to the past or future, it could never realistically accrue to the liver. If therefore a man could be assured of an extra fifty years, although the anticipation might slighly alter his plan of life, he would certainly never seem to possess and hold more time than he does now without that prospect. Even the expectation of a life lasting for ever and ever, as we see, makes no noticeable difference to those who believe they are destined to partake of one; it may indeed alter their motives to some extent, but it does not make them richer in time.

In doing all that is due to be done, in fulfilling its functions, in achieving what it has will and power to achieve, an individual lives a complete life, a life of maximum extent and duration. In this sense a gnat lives as long as a man, a man as long as a god. Life is short only in so far as it is insufficient for its

purposes. To add, then, to the length of life (if we could do so) without adding to its capacities, would be folly. Conversely, too, if only we ran through the complete cycle of life, through the stereotyped seven ages of man, the whole might take ten, twenty, or five hundred years, without being appreciably longer or shorter. At present a life of ten years is short in not conducting one through the full programme—in being prematurely closed. But if, as some other animals do, we grew to maturity in a couple of years, were married at 3, sank into old age at 8, and died at ten, having experienced the chief vicissitudes of human existence, life would effectually be as long as it is now.

But perhaps this subject of the prolongation of life raises issues more of a moral than a scientific nature. I shall therefore conclude these notes with a few observations on the way in which we judge clock time. To speak exactly, we rather guess than judge it. But precisely how we do so I can no more say than I can how a man comes to the conclusion that a parcel he holds in his hand weighs nearer two pounds than three. When I ask myself how much time has passed since I last looked at my watch, I first think what I have done in the interval, and then by a certain feeling estimate it at so much. But there is so far from being any certainty about it that an error of a hundred per cent. is quite to be expected. Experience comes to our help in this way, that it teaches us at about what rate certain things proceed, and how long we generally take in doing certain others—getting up takes so many minutes, a walk to

the station so many, dinner so long, and the like. When such criteria fail, and when such signs as those given by clocks, bells, factory whistles, postman's knocks, dinner-gongs, and so on, are missing, we are hard put to in judging time. All through the day we are constantly checking ourselves in this particular, and so many and easy are the means of doing it that a person can never be very far out in his reckoning. If a man were to go without his watch every other day, he would become much more expert in judging time; for although the frequent consultation of watches and clocks gives us a good grounding in this art, as we so rarely rely on an unaided estimate, skill is never perfected by practice. I think, however, that apart from set routines and the indirect evidence they at length come to afford to experience, no amount of practice would avail much; for in our bare ideas there is so little of the regular and mechanical that, although their succession does in general manifest the passage of time to us, a person may canvass them with the most scrupulous attention without finding the slightest clue to the lapse of standard time. Even if thoughts were regular, and came and went like the pulse, we should have to count them to know how much time had gone: the mere rumination that a great many had passed would not tell us.

If a person is blindfolded, a very little turning about will make him lose his sense of direction; and a very slight inattention, similarly, will obscure our sense of time. It is not even necessary to be deeply absorbed; all it requires is that we should momentarily let the thought that it is such and such a time

drop out of mind, and when next the clock strikes it is quite likely we shall find ourselves counting the strokes to see whether it is one hour or the following, so vague a notion shall we have of the interval. And the guess might be much more uncertain were it not for meal-times, for sunrise and sunset, and a dozen other external indications. It is the same with longer intervals. Living in some place where there were no seasons, no almanacs, no newspapers, and in short where one day passed exactly as another, a man might very soon be a whole year out in his reckoning. Even in the midst of civilization and business it is no uncommon thing for us to mistake the day of the week. But perhaps these last two instances are not strictly apropos, involving as they do rather a confusion in distinguishing between similar periods than any positive insensibility to passing time.

After all, it is not surprising that we should have difficulty in judging time, seeing that it is not in itself anything sensible. Like distance, it is only manifested by indirect means. Where there is no circumstantial evidence, where there are no appreciable changes to deduce from, we are unable to mark the flight.

But—and here I recur to a point which perhaps does not appear sufficiently clearly above—is it not curious that we should speak at all of time going faster or slower, when time is itself that according to which things go fast or slow? Certainly there can be no particular rate of going, no speed, except in reference to time. It remains therefore that in these

cases we must be comparing one time with another, the one of them, taken as standard, being invariable. Thus when we say that time has gone slowly or quickly we are referring to some objectively established time, and mean that Greenwich time, for instance, has increased or slackened its pace in so far as that pace is determined by an absolute or standard time intuitively marked to our minds. It is indeed evident that the conscious time over against which any objectively defined time, now hastens, now lags, can by no means be altered, but must always be perfectly uniform; for how can we tell that a time is variable, unless by one that is invariable? To illustrate this, I cannot do better than take a fictitious case, in which a man is represented as having his appreciation very much intensified by some drug. The consequence is that to this man all actions appear to be interminably slow and long drawn out. One particular will serve us: the clock pendulum seems to have become unaccountably weary, and drags at a crawl from side to side. Now I say that there has been no alteration of time to this man; on the contrary, it must have kept the same to him in order that the pendulum could be recognized to take longer than usual in its swing. For according to what else should the movement be deemed slow but that standard time which a person carries about in himself? and this, as the gauge of whatever is fast and slow, must itself be immutable. It is exactly the same, too, if we reverse the situation, as in the tale where a man is supposed as it were to travel so quickly over the time that the succession of day and night is like winking the eye,

and the seasons and the year pass almost in a moment. But which is the reality, the criterion, here; the moment or the year? The moment undoubtedly, or those changes which usually mark the conscious year could not seem to pass so quickly. As I say, nothing can be conceived that would alter our measure of time; and had the man in our instance not retained that measure, it is obvious that he could never have reckoned the years to pass in a few moments. It is quite a mistake to think that either the winding up of nature in this way to go at a furious pace, or the retarding or reversing of it, would make time go any differently for us; for on, the contrary, it must go in perfect uniformity that we may assign a speed to anything. If, for example, we take photographs of a growing plant once a day for a year, and then run off the series on a cinematograph apparatus, it does not make us think that a second year has passed simply because we see happening what usually takes a year to happen; for we do not judge sensible time from any appearance, but submit the appearance to judgment. Nor can we point to any action of the mind or body as that according to which time goes for us, as our thoughts, heart-beats, or anything similar; for these themselves fall under the appreciation, and are estimated to be slower or quicker. Like other criteria, we see, this one of time is also inscrutable in kind, and cannot be submitted to that sort of comparison of which it is the standard.

It is such considerations as these that manifest the so-called apriority of time; they show, in brief, that no experience is of itself ever sufficient to introduce

or to disturb the sense of time—a fact which led Kant to his subtle speculations and the conclusion that time was a form of thought.

## Survey of Invention

I have often asked myself how it is that while one person finds out all sorts of fresh facts and, in one word, originates in his mind, others should pass through their lives without having perhaps a single really novel idea occur to them. Altogether fortuitous, it has always seemed to me, the case could not be; and although a certain happiness, a certain transcendental element commonly appears to lead up to and guide invention, there is nevertheless reason to suspect that some method or other has at least put the inventor in the way of arriving at his results. In short, I am of opinion that there must to some extent be a technique of invention; and that by familiarizing themselves with this, people now wholly passive and unexpectant in the matter might give themselves a promising chance of initiating, improving, and bringing new things to light. In canvassing the roll of invention with this idea in mind, the following thoughts occurred to me on the subject.

1. If I were to say that to invent or discover something was quite easy yet most difficult, I should only be obscurely and abstractly expressing a fact already as perfectly conveyed as it ever could be by Columbus with the egg. In its essence invention is easy, because

its essence is a thought, that is, a species of perception, and this it is not actually difficult to have. Hence when any invention is made public, it seems easy; for, once the particulars have been brought to our notice, we have only to perceive them—a thing in itself as simple as breathing. It is because of this that almost all inventions we can enter into carry a kind of rebuke with them, reproaching us with our negligence, and causing us a certain remorse that we ourselves did not unprompted light upon the fact or idea. For as in the matter of perception we stand on an equal basis with the originator himself, it seems as if, had we been led in that direction, we could as easily have made the discovery as he. But it is in this exactly that the difficulty consists, namely in taking it into one's head to come to the spot whence that new perception may be had, and in first seeing significance in it.

It is quite in accordance with what I point out, that we should everywhere find people who, though they know nothing, will set about the most baffling problems with every confidence of solving them at the first try. There are thousands, having no special aptitude, who think that with a little attention they would easily be able to contrive a flying-machine, square the circle, and so on. These people have intuitively grasped the fact that in its bare nature invention is such that it may just as well be the work of one man as another. They prove, however, at the same time, that with invention in its entirety, the case is altogether different. Indeed, when he comes to judge from its history, instead of its character, the average man takes a diametrically opposite view, and

concludes that invention, as the result of some special grace, is reserved always for a few individuals enjoying exceptional favours either in power or opportunity. Thus while in principle and with regard to what has been done almost all men think themselves capable of invention; in particular and with regard to what may yet be done few have any serious expectations.

2. If invention were entirely a matter of luck, it would proceed from all classes indiscriminately. This, however, we do not find, having no instance, I believe, of a person in the ordinary mind, engaged in the ordinary routine, making any great discovery. A person in the ordinary mind is at most intent upon arriving at something that has already been arrived at before; he anticipates nothing new, lays himself out to perceive nothing new, and true to his intentions alights upon nothing new. If there is one thing more than another that the history of invention impresses on us, it is this, that discoveries are made by people who are on the look out. It is due to this, too, that the man who discovers one thing, discovers many. Invention, we see, is not a result of indifference, but of inducement and expectation.—"Why did not I think of that? Why did it not occur to me," we say on seeing some simple device.—"My dear sir, you were not on the look out, you did not lead up to it, you did not put yourself in the way of coming upon such a thing. You thought, and you think now, that all the radical improvements have already been made; and the fact is, your whole attitude is one of unpreparedness for anything in the way of novelty."

The people who discover things are those who are imbued with the belief that there is something to discover; for if you do not expect the unexpected you will not find it, as Heraclitus says. The first step towards origination is, then, to feel that there is a possibility of something being hit upon. But hardly any of us ever even go as far as that; we do not so much as consider it possible for us in person to introduce the world to any fact or contrivance it has overlooked, and far less do we think it probable we ever shall. The spirit of invention is so entirely removed from this that we find practically every discovery, down to the most casual, to be the outcome, if not of a specific, then of a general attack. Chance may indeed have had a great hand in it, but it was induced chance—of the sort, I mean, which comes by coaxing. Galvani, whose great discovery is always alluded to as one of the most fortunate strokes, was not passive in the case, but at the time it occurred was distinctly taking steps to find out something about electricity. If other people had been experimenting with flayed frogs, perhaps the fact he disclosed might have occurred to them. But then, that is just the point, that they had not such curiosity, and did not advance towards that half-way station at which nature so often meets the discoverer. Good luck happens to those who make room for it, and are ready to seize it; and if there is any chance in the discoveries great men have made, it is because they gave chance a chance. It is in attempting new things, and in going out of our way to look for them, that we open up these possibilities; and once on fresh

ground there is no telling what may happen—whether what we are directly aiming at or not, does not much matter. It is indeed astonishing what a number of discoveries have been side issues: a man sets out to track down some certain thing, and he finds something else even more valuable. We have only to start out on the excursion, and some adventure is pretty sure to befall us. Columbus meant to strike a new route to India, and discovered America; the alchemists wanted to turn common metal into gold, and founded chemistry: in short, no matter in how unpremeditated a manner inventions and discoveries have directly been made, we always find that the men who made them were up to something when they did so.

3. Romantic as these chance discoveries are, and striking as it is to see on what trivial points great matters sometimes hinge, the mind is even more impressed by the apriori discovery—by those, I mean, which have been deduced from pure theory and are afterwards verified by fact. Newton's law is an example of this, for though it was not announced before being verified with regard to the moon, still to pass from this to "every particle" in the universe was a stupendous transition, emphasizing the supremacy of thought and its transcendental nature in a wonderful way. It was quite theoretically, too, that the same genius evolved his principles as regards the transmission of sound; and it only enhances our appreciation that there was a certain discrepancy in the reckoning, afterwards exactly accounted for by corresponding complications. Another outstanding

example of the kind was the discovery of Neptune; and in my opinion, even if it had been made upon Adam's calculation instead of Le Verrier's, the latter would still have deserved the greater credit, so confident was his prediction, so resolute his conviction. There was nothing half-hearted in his attack; he behaved high-handedly towards nature, advanced intrepidly and carried off the day. A more recent instance of this species of discovery is that of the periodic law in chemistry, by elaborating which Mendelejeff was able to predict several new elements with brilliant success. I have not the slightest doubt but that at the present time there are still a host of facts similarly on record, which require but a simple thought to fuse them into one harmonious and significant whole—facts which, like the pieces of a puzzle, given but a shake, would all slip into their places in a wink. Another example, at any rate of a kindred nature to the preceding, is Galileo's discovery of the law of falling bodies and the fact that originally all things fall at the same speed; for in everyday experience, the contrary is so patent that it must have needed the most searching and original turn of thinking to suspect the true state of the case Galileo is often cited as one of the earliest exponents of the empirical method; but here was an instance where experience had to be positively discounted from, and logic to assert its claim in face of the clearest evidence of the senses; I mean, it had to be seen, in revolving upon the pure principle of the thing, that there was in so far no reason for one thing to fall quicker than another, and therefore that, originally speaking, they

could not do so. To have such an idea at all was highly philosophical.

4. How often does the tale of invention and discovery run after this fashion: "One day, as X. was doing so and so, he noticed, . . . and it occurred to him, . . . . etc, etc." It is always the same; the man noticed some trivial point, challenged it, and there he was, master of a new principle. The history of discovery urges us to be constantly on the look out, ever apprehensive of detail and commonplace, always expectant and with our wits about us. Even if it lead to nothing else, this habit of questioning, of observing points, is very entertaining. One of the best instances that can be given of the effect of expectation on discovery is connected with the detection of the minor planets. In the very first place, that so much as one ever came to be looked for, was the result of a suspicion that nature had no right to be so irregular in the series of the planetary distances as then appeared. The point, however, is this, that after the first four planetoids had been discovered, and this in fairly quick succession, a belief began to prevail among astronomers that no more than this number existed. The immediate consequence was that actually for forty years after no further discovery was made in this field. Upon a fifth being found, however, expectation returned; and since that time not a year has passed without registering its quota of fresh planetoids. So much does the attitude towards the thing mean.—As for the noticing of small things, the keenness of observation that is ever taking hints from slight events and ordinary facts,

I should only be going over familiar ground were I to detail some of the many inventions this has led to. Galileo and the cathedral lamp, Newton and the apple, Columbus and the westerly winds, Young and the soap-bubbles—all these and many similar instances are matters of common knowledge. They only show how essential it is, if we are to throw fresh light on phenomena, to be constantly questioning things and trying to account to ourselves for them. This is how great and new ideas occurred to these men: by constantly seeking and speculating they made them occur. It is not either as if certain people were privileged, and had more facts to go upon than we; but as these examples prove, the way is open to all, and proceeds from a common centre.

5. When Bacon, the apostle of invention, wrote his "Novum Organum," it was the methods that were at fault; and his great point consequently was to urge men to proceed upon the new lines and under fresh conceptions of the matter at stake. Nowadays people are ready enough to collect facts and to experiment in the orthodox way, but what seems to fail them now is rather the assurance that there is anything left to be found out at all—anything at once simple and radical, I mean. The character of invention has lately become so detailed, so technical and scientific, that we begin to doubt whether any great main discovery is still possible. Improvement of existing things and theories—elaboration, in one word, seems to be all that we dare aspire to; nothing of a broad and revolutionary nature is thought of. Modern discovery on this account seems to lack something of

the monumental character which attaches to the historic examples of earlier times: its volume is more, but its scope narrower. Modern books about invention, there is no doubt, go far too much into transports over our latter day efforts. For in thus congratulating ourselves, in saying what wonderful people we are, how splendidly far we have carried things, and so forth, it is made to appear as if in all essential respects the limit had really been reached. A proud and smug sense of satisfaction is thus produced which is detrimental to the genius of invention. The press, too, adds to this spirit; for as it is only concerned with science as a matter of wonder and astonishment, it presents all new thoughts and contrivances in the most exaggerated light; so that superficial things are given a meretricious importance, and people are rather dazzled by what has been done, than set about considering with themselves how to advance a stage farther.

6. The merit of a discovery, the beauty of an invention, we estimate by the joy and satisfaction it would have caused us to have ourselves made it. Hence, other things being the same, a simple invention delights us much more than a complicated, and one in our own line of activity more than one in another line. Again, we think much more of a discovery arrived at by obvious means and common-sense, than of one very recondite in scope and elaborate and technical in operation. We are transported, I say, to read of Priestley and the results he achieved with his homely outfit; of Leuwenhoek, the naturalist, and his improvised microscopes; of Goldschmidt's

discoveries from an attic window, with a small telescope, and cases of this sort. The more so, too, in that accredited men of science, primed up with all the facts of their boasted studies, and having use of the most accurate and elaborate apparati, should so very often be able to evolve nothing of any consequence at all. Still it does not do to be prejudiced, and one must admit that all these improvements in the mechanism of science, as well as in the supply of data, have supplied a powerful lever to the work. We should, however, never allow it escape us, that such arrangements as these are of a merely supplementary importance, and that all great inventions and discoveries have their essence and origin in the mind—an instrument failing which all others will be of no avail, and applying which they may almost be dispensed with. All people are prone to think their own resources more or less insufficient ; and this is particularly the case at the present time, when knowledge has become so specialized. The uninitiated consider the issues involved to be beyond them, and of a class transcending simple reason, so that they never think of approaching them ; while those who are instructed and have access to the most approved equipments, grow proud or become set in their knowledge, and neglect the essential simplicities. Many men nowadays are too scientific ever to be able to reinvigorate the science they affect ; that is, they have got into too artificial ways of thinking. For it is the same with some of these sciences as with certain noble families : close interbreeding, a succession of consanguineous marriages has led to their deterioration ; they have become

enervated, and require some admixture of common blood to restore the balance of vigour and sound health. A glance at any of the papers published by the various scientific societies will show what I mean: the attitude is stilted, conventional, "scientific," and in fine, the whole thing is carried on in an unnaturally rarefied atmosphere.

7. Too much reliance on recorded science is a bad thing for discovery and invention. I do not mean that one should doubt facts demonstrably true, but that one should take it very much less for granted than is now the case that the simple facts of nature have already all been satisfactorily canvassed and reduced to positive science. A certain idea is abroad that all the ground, practically, has been gone over, and that few things if any, in a general way at least, can still be an open question. The average man, consequently, regarding knowledge as in a virtually settled state, thinks that any personal efforts will be superfluous. Hence, when any little phenomenon strikes him, instead of inquiring into it directly himself, the most he will do will be to propose to look up that branch of science and study it. He makes no question but that others will have settled the point long ago, and have thoroughly exhausted the whole subject. And so he leaves it over to them, never dreaming that hosts upon hosts of things have still to be brought to light; that science is imperfect where not erroneous, and that its very life depends upon the personal attention, inquiry and assurance of such as he. This complacency, this airy assumption that all is known and proven, and may be learnt in

a book, is fatal to the extension of science; for it is the habit of satisfying and finding out for oneself, independent of what others may have found, which, leading at first to the duplication of knowledge, enables one at length to originate it. Besides, knowledge that has not been worked up by oneself in one's own way is never really vital and effective. In any case, therefore, a man should always be investigating on his own account, and, while not despising, should not rely overmuch on the science of the day. And this applies, I may add, to the negative as well as positive side of knowledge. It is as well to be a little sceptical, that is to say, not only as to the accuracy of what is thought to be known, but as to the impenetrability of that no less which is pronounced to be unknowable. A great many things which we now see accomplished were formerly deemed to be absolutely impossible; and so it will always be. Conception is not so wide as nature, or so resourceful; and many a matter is therefore impossible until it is done, and insoluble until you have the solution. In this connection we might take a lesson from the unsuccessful attempts we have sometimes made to do toy puzzles. This is often very peculiar: we try this way, that way, all ways; we resort to every expedient, till at last we are as firmly persuaded as possible that it cannot be done, though all the while there is in effect a certain knack, a certain method, that meets the case. These experiences warn us to keep an open mind, and should encourage us to attack difficult problems.

8. Pertinacity is a very necessary quality in all

aims of the kind we are here considering. One or two failures should not be allowed to shake us off, as the cause of them may very well be incidental. Newton's first test of his theory of universal gravitation, for instance, failed because of his employing a faulty estimate of the earth's diameter—by reason, that is to say, of an incidental error. Again, when Kepler's third law first entered his mind, and was submitted by him to the proof, he made an erroneous calculation, and rejected it. On returning to the same clue some two months later, however, he discovered his mistake, and duly made good the famous law. The very important discovery of ether as an anæsthetic was likewise in danger of being rejected through incidental causes. Indeed, the idea actually was discarded by the true originator, for, owing to some carelessness in the preparation of the gas and its consequent deficiency in quality, the first public demonstration proved such a fiasco that he never tried again. The idea was later on revived by others with immediate success. In this particular, then, we are to have a faith opposite to that of common people, who, sinking back to water-level, are always very ready to abandon great attempts, and are inclined altogether to discourage anything out of the ordinary run.

9. Buckle has a well-known passage on the value of imagination in scientific inquiry, and he shows how the pioneers of thought have all possessed and exercised this faculty in an especial degree. As, however, this plea for imagination reflects upon the more literal and matter-of-fact, it has been taken

exception to—nay, resented. It has always seemed to me a striking and influential confirmation of Buckle's view (for no nation is more exact than the French in thought and expression), that the French language should have the word *imaginer* for "to invent," "to devise"—as, for instance, Edison's electric glow lamp is the lamp *imaginé par M. Edison*; the siphon recorder is *le récepteur imaginé par M. Thompson*, and so on. Earlier inventions very often fail by being too literal in their methods. Thus, when the locomotive was in its earliest infancy, three or four patents were taken out by different people for engines which were to go *upon legs*; and when it was proposed to propel boats by steam, the first idea was to make a rowing machine, and move the boat by *oars* working mechanically: the sewing-machine went through the same stage, and many other examples could be given. The inventors who produced these literal imitations seem to have made the mistake of not giving their thoughts a loose; they merely transferred a thing part and parcel from one medium to another, without making any allowance. It did not occur to them that although machinery was required to do the same thing as had before been done by men or animals, it was not, perhaps, the most expedient for the apparatus to do it in the same way. This remark will apply pertinently enough to flying-machines.

10. We see from the above that analogy is a two-edged tool, and requires careful manipulation; for while it has in other cases been the generator of countless inventions, when blindly used it becomes

an actual impediment. Bacon, whose book is a primer on these subjects, has several notes on this; and he shows in some striking instances how analogy, as keeping men in the old grooves, as in fine not being original enough, would never have led to the invention, for instances, of gunpowder as an agent in war, of silk, of the compass, and the like. At the same time, however, the philosopher has another passage to this effect: "There is a great mass of inventions still remaining, which not only by means of operations that are yet to be discovered, but also through the transferring, comparing and applying of those already known . . . . may be deduced and brought to light." To this end, it is a very useful and interesting method to go right through the gamut of invention, and to see whether it does not in one place or another yield some collateral and corresponding ideas. I do not mean that one should get a book on invention to see what has been done; but rather that starting from the nearest object and whatever is at hand or occurs to us, we should extract the principle, and cast about as to whether it might not be extended, transferred, or reapplied in some way. In *particular* the clock in front of me is a thing to tell me when my dinner is due, when I must rise, and so on; but viewing it in *principle* as a means of indicating successive states, or whatever it may be, I see it could be done otherwise; I perceive the essence of the case, and can perhaps apply it differently and newly. Proceeding in this way, we introduce ourselves to the several classes of invention. The clock, for instance, coming under

the general division of "measuring," would call to mind the weighing-machine, let me say, the barometer, thermometer, actinometer, pressure gauge, sunshine recorder, compass, sextant, and so on, *ad libitum*; whence one might be led into curious speculations on the fact that taste and smell have no measure, while on the other hand, the sensitiveness of different parts of the body to touch, has been definitely ascertained by means as simple as ingenious. Comparing things in this manner, new ideas are suggested. A very prolific order of invention is that of combination, of making one of two, as, for example, penholder and inkstand are combined in the fountain pen, envelope and sheet in the postcard, watch and key in the modern watch, cushion and chair in padded furniture, wafer and cover in the gummed envelope, bread and meat in the sandwich, and so on. As balancing this class there is another to an exactly opposite effect. Here we split up instead of conjoining, and make part of a thing detachable, so that in case of wear we need not throw away the whole, but can renew it by replacing the part. The writing quill becoming pen and penholder was an instance of this; and it is also very evident in the matter of clothing which has gradually been divided up into several detachable garments and pieces to meet wear and washing requirements. It is obvious that these classes of invention and the instances they comprise can be extended almost indefinitely; a fact to which the indexes at the Patent Office will bear sufficient witness. But, as it is better for each one to prospect for himself from

his own direct observation and thought, and as it is only in this way that he will become sufficiently interested to strike out new ideas, I need give no further indications of this method or of the several little points that strike one in pursuing it.

11. Everything when it is first made is clumsy, crude and coarse: watches were as big as your hand; pepper-pots, knives, inkstands, chairs, keys, locks, fire-tongs, bicycles and all their parts—all these were on a gross and heavy scale till invention bit by bit reduced and refined them. How many things must still be in the state of this transition, still waiting for somebody to refine upon them just as they are; not even to alter them, but simply to make them less cumbrous? When we look at anything, then, we should ask ourselves: "In what way can this be made neater, lighter, handier; what is superfluous about it?" To weed away what is superfluous, indeed, is no little part of invention and progress, for nearly all early inventions provide for something not needing provision. It is well known that the first electric telegraphs had a return wire to complete the circuit; and in the early days of railway locomotion, inventors laid themselves out with the most complicated devices, to meet the imaginary difficulty of getting wheel to grip rail. Another example that I lately noticed is Jablochkoff's "candle," which gave the first stimulus to electric lighting. The carbon pencils of this light were separated by the originator by a body of plaster of Paris. Later on, however, another inventor dispensed altogether with a separating medium, he

having found that the light would run to the points spontaneously.

12. It must not be lost sight of in the matter of invention that great cost and trouble are nothing, if only the effect is really useful. Machines and installations are often extremely costly, and yet when got into working order soon begin to repay that cost. In the case of gas and water, it must at first have seemed a very impracticable plan to lay pipes all along the streets and in houses, and to set up the big works necessary to supply them; for as against this, the trouble of filling up a lamp or fetching a pail of water seems hardly mentionable. Nevertheless we find here, as in many other instances, that the more complicated way is in the long run the more practicable.

13. In thinking out things for ourselves, we should not be discouraged to find that our ideas have been anticipated. On the contrary, it is a promising sign, as it shows we are able to reach solid conclusions, among which there is no reason but that several may in the future be entirely new. Nor, again, should we be prepossessed in favour of any idea simply because it is new, or because it is our own; but we are to hold ourselves open in the true spirit of inquiry, since the whole reward and satisfaction of any discovery in nature consists in the perception of a fact and the genuine information it yields.

14. Invention must not, of course, begin and end with things material; but the same principle of casting about, questioning, trying, reappropriating, should be carried into other concerns. Bacon,

Locke, Spinoza, for example, are inventors as regards the use of the understanding. Nor must we neglect the way of life, which merely because it happens to be as it is, is apt more than anything almost to be taken for final. For instance, how about getting up and going to bed: might we not try two spells of four hours instead of one of eight for sleep? How about meals? How about business hours, and holidays? Is Sunday a practical institution? How about marriage as we arrange it? How about servants? It is all a question. There is no reason we should not alter our plans. Indeed, how much more interesting, as well as rational, it would be, if we were to act a little less like automata, proceeding not by mere majority and custom, but upon the plain merits of each case.

## The Value of Things

THE actual material value of most things is small, if not trifling; it is opinion or convention that raises it, often out of all proportion. The world regards a little bit of a diamond as the equivalent, say of a labourer's life work—that is due to vain opinion; it much values currently coined gold—half of that is due to convention.

Gold, it is true, is said to have an intrinsic value, in that it is useful as a bare metal, and not alone as money. Yet this value is most obviously affected by the fact that the metal is used for coinage. Were it not that people are ready to exchange all sorts of things, or do all sorts of services for them, you could have the few sovereigns in my purse for nothing, and welcome; for intrinsically or in itself gold is worth nothing to me; I do not delight in it or prize it as such. This is the case with almost all users; for gold itself they do not care, but the conventional value it has causes them to appreciate it. If gold were intrinsically valuable to all and sundry, people would keep it as the very thing they wanted; and this a few do, when the metal has been worked into ornaments; but as a rule we get rid of it for things that we really do value. Another consideration is

the scarcity of the metal; but mere rarity does not lend things value: for example, the piece of note-paper that I have by my side is so scribbled on that it is positively unique and cannot be matched in the world, yet it is valueless. But gold, it will be submitted, has peculiar qualities and peculiar uses, and in so far as commoner metals cannot in these replace it, it must be positively valuable. This I am ready to admit. At the same time, I reckon that about half of the reputed value of gold comes from the fact of its being adopted as a monetary standard, and is thus conventional. If gold fell out of use as a metal for making money of, who can doubt that its value would be depreciated? For though gold vases are doubtless very nice in their way, they are not, apart from the workmanship, so exquisite as all that. However, by people banding together, and making it an agreed thing that they will accept the metal as a common standard of value, it is made valuable. By a similar convention, and by a general and rigid observance in honouring the medium, paper could be taken instead: in the degree, I admit, there would be some difference, but not in the essence of the case. The stamp on it, the fact that it passes current, the fact of people being confident that others will exchange for it, this gives a gold coin at least half its value.

I have seen the Crown jewels at the Tower, and models also of the world's most famous gems; but I thought that the size of these brilliant playthings very much detracted from their preciousness; their very bigness made them vulgar. The fact that these objects represent fortunes engenders respect in the beholder;

but were it not for this, how little would there be to choose between them and some chips of plate glass. For the Cullinan diamond, supposing it thereafter to be unnegotiable, I would give half-a-crown or perhaps five shillings, on account of the lighting effects. That its price is rated so very much above this is due to fictitious elements.

In general people buy jewels simply because it is known to be costly, not because they really value them at the price of a horse and carriage, a house or whatever it may be. Parade is the object. And of how many other things may not the same be said: they are bought because other people put a value on them, not because the purchaser does. Not one half of those who collect rarities, as pictures, old china, and similar objects of art and curiosity, personally appreciate them at the price paid in exchange. They know that these things are in general estimation, and that it redounds to one's credit to possess them; otherwise, and especially if they were not remarketable, their owners would hardly have given a packet of pins for them: they did not delight in the thing for itself, they simply wanted to make a show. This will even apply to houses and land, and equipages and appointments of all sorts; for many will buy these in certain districts and of certain sorts, not because they themselves choose and value them thus, but because of fashion, to move with which gains respect of a kind.

It would be inconsistent to say that what people are ready to pay a given price for is not really of so great value; for in effect this is the price that it fetches. But certainly it is well to recognize that this market

price is often, if not as a rule, absurdly inflated by vain opinion. The net value of a thing I call what it is worth to one personally in and for itself; and it may be estimated by considering to what degree we should care to have the object were we living altogether alone: thus the net value of a string of fine pearls would be very nearly nil. On the other hand, it is impossible to put a price on any possession we positively and absolutely value; for then we are not open to exchange it. Hence, for instance, certain works of art are rightly described as priceless, certain deeds as invaluable; no treasure can command their like. In the market the rarest things are generally the most valuable; philosophically the commonest are so. Air, water, light, heat—what could we do without these? We have them for nothing mostly, but they are not worth nothing. But everything material pales in value before moral goods, upon which, as a matter of course, no price can be set. Unsubstantial as they are, the least of them outweighs the whole earth and all that is on it. If this should seem hyperbolical, let the reader reflect that the only reason we trouble about material things at all, and wish to acquire and possess them, is to set ourselves in a happy frame of mind; in attaining it those things become useless, as you may kick down the ladder when you have mounted the wall.

While the mere scarcity of a thing is not sufficient to lend it value, as I pointed out above, yet if it is once in fashion and demand that circumstance will of course have great influence on the price. To keep up such a scarcity, and regulate the output, is the object

of trade "rings" and "combines." The diamond miners, for instance, must see to it that not too many diamonds reach the market; for that would lower not merely the price, but also the *cachet* of the diamond, which would be fatal to its reign. If every housemaid could buy a brilliant, it is certain that fine ladies would not want them. Thus it is that the fact of a thing being highly priced makes it more valuable: if it cost less, people would not care to have it; so it is kept dear, and people pay as much for the price as the thing.

After necessities have been provided for, and comforts indulged, the only remaining use of riches is to impress people, and to give an idea of our power and means. Now we cannot well go about with bags of money to exhibit our wealth, and so we invest superfluous capital in things known to be costly, that the echo of our riches may in this way strike others and procure us respect. A thing that cost little, however much it might be fancied, would not answer this purpose; hence the value of costliness in itself, and the fact of its adding to the demand for an article. Were it not generally known that gems are costly, the rich would find little object in owning them. Savages buy beads; civilized people stones, called precious. Whatever we may say, there is no great difference between the two.

The influence of high prices in enhancing the esteem and demand for things is especially observable in collecting. Indeed we may tell the genuine from the false collector by the degree in which this circumstance is allowed to operate. A genuine collector is

one who, although no doubt his taste has been formed with some regard to general opinion, pays no attention to the reputed excellence of any object, but judges everything upon its merits and with reference to himself individually. Thus he never buys a thing because of its price, that is to say, because of other people valuing it, but always because he himself finds some excellence and beauty in it which he can enjoy. For this reason he buys for possession, and not, like a dealer, to sell again; so he does not calculate in paying his price what the object would be likely to fetch if sent back to the market. If afterwards his heirs wish to realize his collection, and obtain much less money than was given in bringing it together, it serves them right; they should have been satisfied with the things. No element of speculation or dealing, then, enters into the methods of the genuine collector. He buys, now at exorbitant rates, if he is rich, now at extremely cheap rates; for price is no criterion with him, and he wants the thing for itself. A bogus collector, on the other hand, is a man with a great deal of money but no taste of his own; and so he always buys costly things; for the cost is his guide to the value, and he rather wants other people to admire his collection than himself to enjoy it. These people then buy reputed rarities, as famous old bibles, paintings and ware by known artists, and so on; for all it concerns them is that others should value their treasure. In time, of course, it is the genuine collectors who set the fashion and so bring certain works and their kind into esteem: the others are simply followers; all they do is to

inflate or keep up the price of rarities that have already come into fashion.

This effect of costliness itself to raise the value of things is also seen in the matter of eating and drinking, although it is here not so pronounced. If champagne cost a quarter of what it does, it would be much less affected by the rich than now—I mean, it would no longer be ordered for distinction's sake as at present; but the wine being intrinsically a good and pleasant drink, it would always find consumers, however cheap. Thus the present value of champagne is partly genuine and partly artificial: the value of diamonds, on the other hand, to illustrate the difference, I believe to be almost wholly artificial, for there can be no doubt that if they were as plentiful as blackberries they would be left lying. Caviare is prized partly for its taste, but mainly because of its price; as, on the contrary, many excellent edibles are ignored by wealthy people simply because they are cheap. Thus are we, and especially the rich, duped by foolish custom and love of ostentation.

Again, many shops are patronized, many hotels, many resorts, simply because they are dear: the dearness shuts out the common herd, and introduces exclusiveness, and for the privilege of being one among an exclusive set of people, the rich are generally ready to pay fancy prices. The idea is to do or have something that is beyond the means of ordinary people, and so to mark oneself out: actual value is not attended to; show is the object. But the exclusiveness that depends on external things is at best precarious; and so all these devices are

empty, unless there is some inner quality, some personal treasure to back them. Let a man only be something or do something, and he at once enters the most select company; otherwise he is of the rabble, though he pay a fortune to extricate himself. However, it is easier to buy false regard than to earn true; and so we allow fashion to prevail where it should not, and get well cheated for our pains.

To preserve ourselves as far as possible from these follies, we must revise our values, and be careful to see, when we purchase, that we are paying for the thing, and not for the price of it. Let us not be blinded by mere repute, but let us consider what the things are worth to us personally. Those who do this will find that there are a great many bargains to be had in the world, and, while buying precious things cheap, will often have the advantage of not coveting what is dear.

In pursuing these thoughts on the value of things I am naturally led to consider the standard by which we commonly value them—money. And to that disagreeable subject accordingly I propose to devote my remaining pages, remembering as far as possible that it is one in which precept and practice have not usually agreed very well together. What moralists say about money is applauded but not followed; and, in secret, we think that if they condemn it, they must be either knaves or fools. Certainly I am myself much indebted to money, and I should like to be able to say a good word for it; but for some reason I feel much more inclined to abuse it.

Homage enough, in all conscience, is tacitly paid it in real life, without adding written testimony.

However good a case a man may make out for money, he cannot dispose of the fact that a certain bad odour clings to it. Its utility is patent, it is the life-blood of civilization; nevertheless there is that about money which brands it as low, as contemptible. Be as practical as we will, we cannot remove this stigma: the brightest piece they coin at the mint is tarnished. If that were not so, why should it be such an uncomfortable thing to have to ask for money, nay, to accept it even? Why should it be ignoble to scheme much for money, to care overmuch for money? How is it that pecuniary considerations are the lowest? I can only surmise that it is because money is the emblem of material want; that it is because money stands for all those things whereby we are placed in dependence, and not for any by which we have inherent power. Money has to do with that element of life which the free soul scorns; hence probably its vulgar character and bad name.

It is only fair to add that there are cases in which it is more honourable to be particular in pecuniary matters than indifferent about them. This is when indifference leads to impecuniosity; for in general it is dishonourable for a man to be reduced to a state of destitution, and to be dependent on charity. If it is to prevent this that a person makes money his sole aim and care, who shall say that he is not pursuing the most worthy course. Nevertheless there are some engaged in unremunerative work, as poets, artists, inventors, and so on, whose impecuniosity is

by no means dishonourable to them; for it sometimes happens that the very improvidence which may be laid to their charge is of greater benefit to society than their possible prudence could have been; and that in omitting their duties to themselves, they have all the better fulfilled those towards the species. Had many of these men worked for a wage, instead of as they pleased or for fame, their splendid legacies might never have been bequeathed; for whatever is produced with an eye to money is done with an ulterior object, which disturbs the purity of the attempt; but in what is done for its own sake, there is only the single object in view, and so the result is of a truer and more perfect order. To be sure, it is disgraceful that a famous man should be under the necessity of accepting some miserable dole from the state; a vile thing that a subscription should have to go round for him, or that he should die in debt. Still, as children of the public, and as endeared to the public as well perhaps by their faults as their genius, we are inclined to make some exception in the case of such men; for what they forfeit in respect is as nothing to what they have earned.

Money can be exchanged for things as they are fancied, and in so far it may temporarily put us out of our wants one by one; but it leads to no radical alleviation, and does not remove us from the defective state of continually being in want. For this at bottom is a concern of the mind or heart itself, which, incapable of material aid, must be raised by a certain internal effort or intention, until, restored to

its true tone, it spreads life and abundance of its own.

What men more especially desire in the way of money is a surplus; it is extra money, spare money, they so much want. Whatever our income may be, it is always appropriated to certain objects—a certain sum for this, a certain sum for that, and so on. In this there appears to be a kind of obligation and restriction; and so we imagine another sum above and beyond the given amount, which we should actually be free to spend without accounting for it and just as the fancy took us. For in the ordinary course we can hardly spend money without feeling that we are thereby diminishing the stock of what we have to spend; and that acts as a check, and prevents us from being entirely at liberty with our money. In contrast to this we figure to ourselves a certain extra or magic amount, the spending of which would leave us as we were, our means undiminished, our capital intact.

This circumstance, indeed, may be accounted a positive drawback to money, that the more we value it, the less are we freely able to spend and so turn it to actual profit; for the very consciousness of its worth makes a person loth to part with it, and causes him, in buying one thing, to regret the thousand others that that purchase makes inaccessible. Thus the satisfaction that a man promises himself in spending is sometimes turned into positive distress: the thought of what he is gaining is over-balanced by the thought of the many alternative things he is, in consequence of that one gratification, precluded from having. Before

the money is spent there are infinite possibilities with regard to the satisfaction it may be turned into; and once it is spent these are infinite impossibilities. Spending, therefore, is in so far a losing transaction; and yet, on the other hand, not to realize money is to deprive it of all substantial value. This dilemma produces the miser. It is also the cause why, no matter how much he may have, a man is never quite rich enough: the more he allows himself to be lavish with his money, the more he reduces his power of being lavish with it. The spendthrift alone is able to disregard this point, and to use his money with absolute freedom; but he, as we know, soon runs through his resources and arrives at an unenviable state.

Some people show their love of money most in the pains they take to acquire it; others most in the care they take in spending what they have. Some earn their income by making money; others by saving it. The latter may be excused if they are by way of being parsimonious; for this quality is only blameworthy when it accompanies love of gain. Some combine both characters, and spend without scruple in one or two directions, whilst in other respects they are almost miserly. These are the people who, having certain pet schemes, and wishing to be able to indulge in them freely, are jealous of money absorbed in other ways.

While money is of so much account with us, it is interesting to observe that all other creatures pass through life quite sufficiently and enjoyably without it: they have no means, but yet they are rich. Even

among ourselves money is powerless in these three respects—intellectually, æsthetically, and morally. And when we reflect what extent of life is embraced under these heads, we well see how incumbent it is upon us to pause in time, that, searching out eternal standards of value, we may enter into our estate.

## What We Learn

—" The learning of many things teacheth not understanding."—
Heraclitus.

To see what a great deal has to be learnt during life, it is sufficient to reflect that we arrive in the world utterly ignorant. Having learnt an appalling variety of things, our personal knowledge dies with us, and the process has to be begun again. This goes on all over the world in countless individuals, and in the race as a whole, each generation having to begin afresh. Nay, life itself may be regarded as one indefinitely protracted piece of schooling, during which we are constantly gathering fresh particulars. When at last we have accumulated a vast store of facts and ideas, and have attained our most comprehensive view of things, the entire scene abruptly closes; and with it goes all that we had so laboriously collected and ordered in our heads—the mansion with all its furniture falls to the ground; " the book and the volume of the brain " has all its characters erased, like writing on the sand.

This constant obliteration of what is so slowly and so painfully acquired, this wanton undoing, is nature's candid way of showing us that quantity of knowledge is of no account. If it were of any value,

the course of things could not thus be continually reducing the sum to nought. If it mattered how much, how many particulars, or even principles, man knew, nature could not, I say, be so fiendish as deliberately and repeatedly to sweep away the carefully accumulated contents of the mind whenever it was beginning to possess something of a supply ; it could not thus tantalize and provoke itself in an aim ; it could not thus eternally stifle the growth, break off the thing begun, dissipate the fortune gained. What had been amassed by one would then descend to the successor, who in turn would add to the stock, and so forth in ever increasing gain. As things are, however, each individual starts with nothing, with a *tabula rasa* which, no sooner is it filled, than it is cast aside like an old exercise book. This proves that what is in it is useless ; that all the pictures, memories, abstracts, forms, and signs it contains are so much lumber, fit for nothing but to be got rid of. Indeed, to say nothing of having this jumbled mass of odds and ends transmitted to another for him to start upon and add to, it is marvel enough that one small brain can submit to such a packing. Perhaps even it would be a good thing if during life itself we could once or twice slip the endless chain of thought, forget all we had noted, and commence anew. But the storage goes on ; every hour brings in its fresh impressions, and so many and so various are the objects systematically catalogued in this living index of ours that I wonder we do not all go mad.

We inherit, then, a mind, but not the contents of one—a fortunate circumstance, duly considered ; and

one, as I add, calculated to impress upon us that while the faculty of thought is everything, the amount of material got together in the head must be indifferent, or it could not be periodically annulled, as we see it is. Let a man be ever so learned, he cannot carry so many facts as an encyclopædia. This competition, then, he ought to renounce, and pride himself rather on the vitality of his mind; for it is in this particular alone that we have advantage over books, which, however much they may be stored with information and recondite examples, cannot produce a thought or make an observation as the living faculty can.

Of the things that we learn quite one half, I should judge, are arbitrary, and tax memory rather than understanding. In this division fall all signs, standards, and methods made current by general convention. To know the more common of these is almost indispensable if we are to have relations with our fellow creatures, to take our place among and exchange ideas with them; but there is no science in such a knowledge. Let me explain a little more concretely what I mean. In learning to speak, to read and to write our own language we fix in our mind certain signs or forms; but that such and such names stands for such and such things, that the names should be spelled in a certain way, and written in certain characters, is a matter of agreement simply, not of nature or necessity. Nor is the agreement more than limited either; for we have only to travel a few stages to find an altogether different set of names, spellings and characters in use. I therefore say that in learning a language, and how to write and decipher

it, a person has not possessed himself of any rational knowledge; he has simply mastered a certain artifice, has acquainted himself with a code fixed upon by a group of people. Yet a great part of education consists in teaching languages, and we even add dead languages to the list. Not that I wish to imply that it is of no advantage to learn languages, for obviously there are advantages in it; merely it is to be remembered that they have no intrinsic value, and that to know one does not represent any accession to actual understanding.

Exactly the same may be said of numbers, weights and measures, and especially of all the technical terms with which science as taught in books or at schools so abounds. Indeed, in so far as education is formally communicated, a third part of it is mere nomenclature. Yet to have a command of these terms and tokens is not to understand anything, for they are adventitious one and all. Other standards might serve for weighing and measuring, the decimal arrangement is not essential to a system of numbers, and other names and terms might as well denote what those we now use do. In committing these thousand and one particulars to the mind, then, we simply familiarize ourselves with certain expedients useful as a means of acquiring or transmitting ideas: we do not exercise our reasoning powers or get any truth of things into our heads.

Higher education is as bad as elementary in this, if not worse. Whether it is our own bodies, or the earth and the beings on it, or matter and the changes of it; whether it is physics or chemistry, biology, paleontology, anthropology, geology, mineralogy;—whatever

the science may be, about a third of the pupil's attention is taken up in learning what that science calls things, and orders of things or parts of things. Such and such is the name of a family of plants or birds, such and such is the name of a species ; this part of a plant is called the *pistil*, that the *stamen ; hydraulics* isdivided into *hydrostatics* and *hydrokinetics ;* an *acute* angle in this, an *obtuse* that ; the *Caspian* sea receives the *Volga* and *Ural* rivers. And so it goes on, until one begins to wonder whether there is any content, any matter at all in what we learn. It is of course very convenient to have settled names for things, and important to know them for the sake of understanding and being understood by others ; but it should be remembered that such knowledge does not involve the intellect, or come to it as a genuine and living possession.

I am sorry that this is never borne in mind when it comes to be a question of a person's ignorance or the reverse ; because we thus get to take pride in being familiar with the mere habiliments of science, instead of in alacrity and exercise of mind. It is very stupid of people to be ashamed of themselves for not knowing the names of trees and flowers, of the constellations, and various particulars of this nature, all of which are artificial and conventional, and form no intregal part of science itself. If at all, a person ought to be ashamed of his essential ignorance ; that is to say, of not having thought, not having observed, not having exercised his wits.

These remarks apply also with some modification to mathematics, of which since Newton's time science

has become so full. Calculation does not necessarily give one an insight into things, nor does it always by any means bring intelligence into play. The proof of this is that there are *machines* capable not only of carrying out the more simple operations of addition, multiplication, and the like, but of computing areas and solving complex equations—I allude to the planimeter and integrating machines. The danger of mathematics lies in its formality. It is a kind of dummy science; and unless a man is careful to conceive what his figures and letters actually represent, he may go on manipulating indefinitely without getting a single idea into his head. I often wonder, when I see an equation several lines, and perhaps a whole page, long, whether the person who has written this down can have had a clear, concrete, detailed idea of what it represented in nature. Indeed, as far as thought goes, the invention of the differential calculus and other mathematical methods has not been altogether a gain.

Besides a smattering of these and other sciences, people are supposed to get some information of what happened in the world before they came there—I mean, what happened among their own species; for we have no political or genealogical accounts of other species, telling us, for instance, that sheep $A$ begat sheep $B$ and $C$, that a tribe of bees called the $N$ chose a certain individual for queen, who reigned over them for a length of time, and so on. But human history is also endless, and also indistinguishable if we go far enough away in space or backward in time. The more remote it is, the less we can tell one king or people from another, one battle or conspiracy from

another, and the less we care which is which. History repeats itself; and so, except it concern people more immediate to us in nationality or feeling, is tedious and empty. That we should even go beyond this, and enter into the details of a single man's life, as in biography, might seem petty; but what a biography loses in breadth it gains in depth; it is nearer to us, more intimate than history. Again, even the most unprincipled are arrested and charmed by conspicuous conduct; so that great actions and noble bearing, though past or distant in fact, seem ever close and present. They both flatter and inspire us, and form a fine subject matter for study. Nor is vice uninteresting. In glancing at its many specious forms we may perhaps be reminded of ourselves, if not as we are, then as we might be.

Another advantage of history is that it gives us an outside view of human events; for what we are ourselves engaged in we cannot so coolly judge. This view, precisely because it is dispassionate (that is, lacks will, which gives value to things) shows us that there is very little worth aiming at; for what with the precariousness and instability of all affairs, one condition hardly seems preferable to another. In the view of history, life seems to be a turmoil all about nothing. The ends gained do not answer the means, and whatever is arrived at, it quickly passes away. History, then, may also have the highly useful moral effect of manifesting the vanity of the world. But as to our being ignorant of historical dates and names, we ought by no means so to defer to pedantry and schooling as to be in the least ashamed of it. It is

the general view alone that should concern us, and the thought and insight this leads to: the details are infinite; no one can compass more than the merest fraction of them, and they are immaterial at that.

Superimposed upon general knowledge, we usually have the particular one that fits us for our calling. The latter very often drives out a good portion of the former, which in truth was never really acquired, but merely temporarily borrowed. How very little, indeed, of what we are taught, do we learn! how very little is turned into living knowledge! That knowledge must be rooted in experience, must be gained in practice and from the things themselves, is a commonplace; but it still requires insisting upon. You can only learn how to do a thing by doing it, and you can only learn a fact by finding it out. What we are told we never really know about; we have got either to observe or work it out for ourselves. I do not mean that scientific facts have one by one actually to be re-discovered; but a basis, a grounding of first-hand personal observation and thought must exist, if communicated ideas are to take root in the head. Most important truths are luckily of this kind, that though it takes consummate genius to see them for the first time, they can thenceforward be grasped by almost any schoolboy—so great is the difference between perceiving what no one has noticed and perceiving what is pointed out. It is due to this that although science is ever advancing, ever gathering fresh material, its stock never really gets much bigger; for fundamental facts, after a time, are easily and briefly stated, and, in taking their place, they

automatically cancel other points and teachings up till then thought indispensable. In this way no generation has positively more to learn than another, though each no doubt thinks itself harder pressed than its predecessor. Certain natural checks operate here as in the matter of population, and were I a Malthus, I could show how science is prevented from indefinitely increasing. Thus, then, what it has taken millions of men and thousands of years to find out may subsequently very often be acquired in a few hours. The inquiry of a life-time goes into a single line; and so with thousands of contributors and correctors, is the book of science gradually set up.

Other things we learn for grace or diversion. There is music, for instance, and the art of playing some instrument. Months have to be spent to acquire even a slight mastery in this kind, so arduous it is to learn, I will not say, to do things well, but to do them at all. Drawing and composition are also practised; and on the theoretical side, an educated person is expected to know something about the principal masters of the fine arts, their characteristics and their works. Not only are the subjects for study innumerable, but each subject itself opens up an infinite prospect. In the way of diversion we learn perhaps more than in the way of study. All games, physical and otherwise, come under this division. Each game has its own rules, its own order of play, and each calls for its special skill and management, which are learned to perfection only after years of practice. Cards are a world in themselves for variety, and chess for depth and

stratagem seems to be the same. Physically there is riding, swimming, rowing, shooting, and so on, not to mention the set games; and in all of these there is a certain knack and method to be acquired, and not easily either.

Let us add to this by way of example and as showing the heterogeneity of the material we accumulate in our heads that we are every day acquainting ourselves with news from all quarters of the globe; that we follow in detail the principal murder trials, law suits, debates, accidents, matches, races, functions; that we learn who's in or out of town, what the plot is of to-day's new novel or last night's new play, how concerts go off, how pictures are hung; in short, that we read the newspaper. And let us further add the local and domestic information that we gather day by day; for we manage to keep posted up in the affairs of dozens of other people, know where they are, what they are doing, how much they earn and spend, what they say, what they intend, and in fact all about them.

This enumeration might be continued indefinitely; and the marvel is, as I say, that one small noddle can contain so much without bursting. Nor is the assortment less wonderful that the quantity—good thoughts and bad, abstruse and simple, grand and petty, trivial and important, personal and general, are here all thrown together, jostling in precipitately one upon the other.

Since, then, there is no limit to particulars, it behoves us rather to master the principles that include them; that is to say, to make our knowledge

philosophic. The end of knowledge is comprehension, or the seizing of many things together. It is most important, therefore, to weld our information —to focus it; and most important also to keep the mind pliable; not to overload and deaden it, but to quicken it by interesting exercise and observation. The way to do this is to be careful that there is always some substance to our thought, and not to let it grow attenuated. Some impression that we have direct from the world of reality should always base our study, for only in this way are the resulting ideas living and fertile. We can tell this in putting them to paper: if the thoughts are forced, abstract, remote, it is a labour to work them out, and the effect is dry and stilted. A vivid thought, on the contrary, wings its way; it draws the man with it, excites and interests him. This braces the mind, and leads to an expression which is at once nervous and lucid. It is extraordinary what a difference hearty attention and interest make, which can only be had by entering into things in our own way and according to our own special tastes and proclivities. How is it, then, that most books of science (and you may throw in any miserable production of my own where the description applies) should be so stiff and stodgy, so flat, stale and unprofitable? Because they are "scientific," and because science has become too formal, too professional. The manners interfere with the thing, and do not allow the investigator to be his natural self. What a deal of affectation there is in present-day science—a special kind of snobbery, which consists in being immaculate in one's frock-

coat of mathematics and technical terms, but otherwise, oh, how conventional and correct! We shall never really get on in the scientific way until we make some sacrifice of this rigid dignity. We are out and out cowards, and dreadfully afraid of showing ignorance, as if that were the only disgrace. No, indeed; the disgrace lies in daring nothing but what you are sure of, in cloaking that ignorance under an air of learning, in avoiding ingenuous and straightforward issues.

Well, people lose a great deal by the fear of making fools of themselves, and in leaving their science all to be found out for them by others; to be your own scientist, at any rate in certain branches, or in a supplementary way, is so excellent a recreation. Besides, science ought not to be left entirely to professionals; it would soon stagnate if it were. Why should we not have an occasional beanfeast in knowledge, going where angels fear to tread, throwing stones at empty ginger-beer bottles, and having a rousing chorus on the way home! A little rampaging would not hurt science by any means. It is too prim and proper at present, and we are too afraid of it; it wants rougher handling. Doctrine dictates to us, tyrannizes over us; for freedom of thought is not conveyed by parliaments, but a man must take it to have it. So much is this so that it affords everyone a genuine pleasure to hear that some long accepted scientific theory has been upset, for when this happens we feel it as a vindication and reassertion of the living spirit within us, which in its nature is autocratic, and demands

that everything shall submit to it. Not that the intellect is unwilling to accept truth, or feels it a submission to assent to it as such; but the faculty hates having a truth forced upon it by mere authority, and requires rather that the truth should bring its own assurance.

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Like a speaker who has been long on his feet, who does not well know how to regain the main thread of his discourse for the peroration, and in this dilemma abruptly sits down, so here do I break off my remarks, satisfied rather in not having unduly prolonged them, than in having brought them to a suitable conclusion.

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